AMERICAN SOCIETY
FOR
TESTING MATERIALS

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

PROCEEDINGS

OF THE

TWENTY-FIRST ANNUAL MEETING

Held at Atlantic City, New Jersey
June 25–28, 1918

VOLUME XVIII

PART I. COMMITTEE REPORTS
TENTATIVE STANDARDS

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ATLANTIC CITY, N. J., JUNE 25–28, 1918.

THE TWENTY-FIRST ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS was held at the Hotel Traymore, Atlantic City, N. J., June 25–28, 1918. The following is an analysis of attendance at the meeting: Members in attendance or represented 475; guests, 129; total, 604; ladies, 108. The corresponding statistics for the Twentieth Annual Meeting are: Members in attendance or represented, 507; guests, 90; total, 597; ladies, 154.

The names of the members who were present or represented are given in Appendix I to this Summary.

FIRST SESSION—TUESDAY, JUNE 25, 10 A. M.

Vice-President S. S. Voorhees in the chair.

The Vice-President explained that the President, Gen. W. H. Bixby, was unavoidably absent on account of his connection with Government work, and at his request the following letter from the President was read:

ST. LOUIS, MO., June 16, 1918.

Messrs. A. A. Stevenson and A. W. Gibbs,
Past-Presidents and Members of the Executive Committee,
American Society for Testing Materials, Philadelphia, Pa.

My dear Mr. Stevenson and Mr. Gibbs:

Up to within the last few days, I have been hoping and even expecting that I should be able to attend the coming annual meeting of the Society and preside thereat. But, instead of my work lessening, it has been increasing. Moreover, Congress has not made the expected progress in its appropriation bills (River and Harbor, and Sundry Civil bills) connected with the work of my Division and the Mississippi River Commission; and until they are passed, I have to be here on hand to make special reports on immediate telegraphic calls from the Engineer Department or from the Congressional Committees or perhaps both. More than this, I assume that you have seen

in the papers recently that the Chief of Engineers has just started to organize and commission several more regiments of engineer troops; so that daily I am called upon to examine and commission (or rather recommend for commission) officers who are being called to immediate service with troops expected to start immediately for the other side. I seem to be the only ex-engineer retired officer available for such examinations for the States of Arkansas, Missouri, and Iowa, and west therefrom to the Rockies. The next nearest officers so available are at Chicago, Cincinnati and New Orleans. In addition the U. S. fiscal year ends on June 30, and all sorts of reports have to come in and be passed upon during the last week of the month. All this makes it practically impossible for me to get away from my present station during the last week of the present month. I am very sorry for the unusual complications; but I do not see that they can be avoided. Consequently I feel obliged to call upon you two Past-Presidents to take charge at the coming meeting of the Society, and to act there in my place. I shall have to leave to you to decide how far the Vice-Presidents can be called upon for such service, as my understanding at present is that they are tied up by War Service at present even more effectively than myself.

Regretting the above complications, I hope that the Vice-Presidents, the Executive Committee, and the Past-Presidents, will all do that is possible to make the meeting a success.

Very truly yours,

(Signed) W. H. BIXBY,
President, A.S.T.M.

The Vice-President then referred to the absence on account of illness of the Secretary-Treasurer, Mr. Edgar Marburg.

The following resolution introduced by Past-President A. A. Stevenson was unanimously adopted by rising vote and telegraphed at once to Mr. Marburg:

> "The American Society for Testing Materials in meeting assembled express their sincere and heartfelt sympathy for their honored and worthy Secretary and wish him a speedy recovery and an early return to the duties he has so admirably and ably conducted."

On motion of Mr. Stevenson the following resolution was unanimously adopted by rising vote and telegraphed to the President:

> "The American Society for Testing Materials in meeting assembled regret that you could not be present, but appreciate the conditions and wish you success in the many duties you have undertaken in these strenuous and serious times."

The minutes of the Twentieth Annual Meeting were approved as printed.

The Vice-President appointed Mr. S. R. Church and Mr. F. N. Speller as tellers to canvass the vote for officers.

The Assistant to the Secretary presented the annual report of the Executive Committee.

The Assistant to the Secretary moved, on behalf of the Executive Committee, that the following amendment of Article II, Section 5 of the By-laws be referred to letter ballot for adoption:

Add the following new paragraph to Section 5:

> "The Executive Committee shall also be empowered to elect an Assistant Secretary at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary shall be fixed by the Executive Committee."

Mr. A. A. Stevenson moved that this amendment be revised to read as follows by the insertion of the italicized words:

> "The Executive Committee shall also be empowered to elect an Assistant Secretary *and an Assistant Treasurer* at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary *and Assistant Treasurer* shall be fixed by the Executive Committee."

This motion was carried and the amendment as revised was unanimously referred to letter ballot.

The Assistant to the Secretary moved, on behalf of the Executive Committee, that the following amendment to Article III, Section 2 of the By-laws be referred to letter ballot for adoption:

For the sixth sentence, which reads:

> "The members of the nominating committee for the previous year shall not be eligible for appointment on this committee for the immediately succeeding year.",

substitute:

> "The members of the Nominating Committee for a given year shall not be eligible for appointment on this committee for the immediately succeeding year."

Mr. A. A. Stevenson moved that this wording be revised by the elimination of the word "immediately".

This motion was carried and the amendment as revised was unanimously referred to letter ballot.

The proposed amendments of Article VI, Section 1, of the By-laws recommended by the Executive Committee were unanimously referred to letter ballot.

Mr. J. A. Capp moved that, in pursuance of its request, the Executive Committee be authorized to publish the Book of A.S.T.M. Standards in 1918 as planned, and the next one in 1921. This motion was unanimously carried.

The report of Committee E-3 on Revision of Pipe Threads was presented by Mr. J. A. Hance, representing the chairman, Mr. H. V. Wille.

The report of Committee E-5 on Standing Committees was presented by the Assistant to the Secretary in the absence of the chairman, Mr. Edgar Marburg.

The report of Committee E-4 on Magnification Scales for Micrographs was introduced by its chairman, Mr. W. H. Bassett. On motion of Mr. Bassett the proposed amendments in the Tentative Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2–17 T) were accepted and the Definitions continued as tentative.

The Assistant to the Secretary presented the report of Committee E-6 on Papers and Publications in the absence of the chairman, Mr. Edgar Marburg.

The report of Committee D-7 on Timber was presented by its chairman, Mr. Hermann von Schrenk. Mr. von Schrenk moved that the proposed Tentative Specifications for Wooden Paving Blocks be amended by adding the words "for Exposed Pavements" to the title and by adding the following new Section 1:

> "These specifications cover wooden paving blocks for pavements exposed to alternate wet and dry conditions, as distinguished from pavements which are used under cover and protected from atmospheric influences";

and that the specifications as thus amended be accepted for publication among the tentative standards of the Society.

After considerable discussion Mr. W. H. Fulweiler moved as an amendment that Sections 7 to 9 inclusive of the specifications, relating to preservative, be referred back to the committee. This amendment was lost.

Mr. A. A. Stevenson moved as an amendment that the appendix at the end of the specifications be incorporated in the specifications as a note. This amendment was adopted and the specifications as thus amended were accepted as tentative.

On motion of Mr. von Schrenk the Tentative Methods for Analysis of Creosote Oil (D 38-17 T) were referred to letter ballot of the Society for adoption as standard, to be incorporated, if adopted, in the present Standard Methods for Sampling and Analysis of Creosote Oil (D 38-17).

On motion of Mr. von Schrenk the following specifications were continued as tentative:

Tentative Specifications for Selected Structural Douglas-Fir Bridge and Trestle Timbers (D 23-16 T);

Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted (D 24-15 T);

Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted (D 25-15 T).

The report of Committee D-13 on Textile Materials was presented by its chairman, Mr. G. B. Haven, who recommended certain minor changes in the proposed revised Tentative General Methods for Testing Cotton Fabrics appended to the report. On motion of Mr. Haven, these changes were approved and the Methods accepted for publication among the tentative standards of the Society, with the understanding that they will supersede the present Tentative Methods (D 39-16 T) of that title as well as the following Tentative Tests: For Automobile Tire Fabrics (D 31-16 T); for Cotton Fabrics for Use in Hose, Belting, and Similar Articles (D 32-16 T); for Cotton Fabrics for Use in Bags and Bagging Material (D 33-16 T).

The tellers on the votes for election of officers presented their report, and in accordance therewith the Vice-President announced the election of the following officers:

For President, to serve for one year: Guilliam H. Clamer.

For Vice-President, to serve for two years: George S. Webster.

For Members of the Executive Committee, to serve for two years: Guilliaem Aertsen, C. K. Burgess, G. B. Heckel, K. W. Zimmerschied.

The Vice-President appointed Past-Presidents A. N. Talbot and A. A. Stevenson to escort the President-elect, Mr. G. H. Clamer, to the chair. Mr. Clamer expressed his appreciation of the honor conferred upon him by election to the presidency and pledged himself to the faithful discharge of his duties.

The meeting then adjourned till 3 P. M.

SECOND SESSION—TUESDAY, JUNE 25, 3 P. M.

On Wrought Iron, Cast Iron and Testing.

Mr. J. H. Gibboney in the chair.

The report of Committee A-2 on Wrought Iron was, in the absence of its chairman, Mr. H. E. Smith, presented by the secretary, Mr. J. B. Young.

Mr. Young moved that the proposed revisions in the Standard Specifications for Lap-Welded Charcoal-Iron Boiler Tubes, Boiler Flues, Safe Ends, and Arch Tubes for Locomotives (A 38–16) contained in the report be referred to letter ballot of the Society for adoption as standard, as well as certain additional revisions in Section 11 on Workmanship.[1]

This motion was unanimously carried.

On motion of Mr. Young the proposed revisions in the following specifications were unanimously referred to letter ballot of the Society for adoption as standard:

For Engine-Bolt Iron (A 40–13);
For Refined Wrought-Iron Bars (A 41–13);
For Wrought-Iron Plates (A 42–13);
For Iron and Steel Chain (A 56–15).

On motion of Mr. Young, the following Tentative Standards, revised as indicated in the report of the committee, were unanimously referred to letter ballot of the Society for adoption as standard:

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[1] These revisions appear in detail in an Addendum to the Report of Committee A-2, p. 155.

For Staybolt Iron (A 39–17 T)—to replace, if adopted, the present Standard Specifications for Staybolt Iron (A 39–14);
For Wrought-Iron Pipe (A 72–17 T);
For Wrought-Iron Rolled or Forged Blooms and Forgings for Locomotives and Cars (A 73–17 T).

The report of Committee A-3 on Cast Iron was presented by its chairman, Mr. Richard Moldenke. On motion of Mr. Moldenke, the Tentative Specifications for Cast-Iron Soil Pipe and Fittings (A 74–17 T) and the proposed revision in the Standard Specifications for Gray-Iron Castings (A 48–05), were unanimously referred to letter ballot of the Society for adoption as standard.

The recommendation of the committee that the Tentative Specifications for Railroad Malleable-Iron Castings (A 75–17 T) be referred to letter ballot for adoption as standard, was, on motion of Mr. Moldenke, withdrawn from the report and the specifications were placed in the charge of the newly organized Committee A-7 on Malleable Castings.[1]

The report of Committee E-1 on Methods of Testing was introduced by its chairman, Mr. G. Lanza. On motion of Mr. Lanza, the proposed revisions in the Standard Methods for Testing (E 1–16) were referred to letter ballot of the Society for adoption as standard.

A paper on "A Simple Type of Brinell Testing Machine for 500 kg. Load" was presented by the author, Mr. A. V. de Forest.

A paper entitled "A New Method of Obtaining Brinell Hardness" by Mr. J. G. Ayers, Jr., was, in the absence of the author, read by title and discussed jointly with the preceding paper.

The following papers were then presented by their respective authors:

"Effect of Moisture on the Tensile Strength of Aircraft Fabrics" by Mr. G. B. Haven.[2]

"Transverse Testing Under Non-Uniformly Distributed

[1] For report of this committee, see p. 29.

[2] This paper is published as an Appendix to the report of Committee D-13 on Textile Materials. See p. 380.

Load with Special Application to Airplane Wing Ribs" by Mr. I. H. Cowdrey.

A paper on "Sumner Elastic-Limit Recorder" by Mr. J. L. Jones and Mr. C. H. Marshall, was presented by Mr. Dean Harvey.

The Assistant to the Secretary read the following telegram from President Bixby:

> "Present to the Society my sincere regrets at inability to be present, and my best wishes for a successful and enjoyable meeting."

The meeting then adjourned till 8 P. M.

THIRD SESSION—TUESDAY, JUNE 25, 8 P. M.

Vice-President S. S. Voorhees in the chair.

For the information of the members and guests present, the Chair read the resolutions which had been adopted at the first session and telegraphed to President Bixby and Secretary-Treasurer Marburg, and the telegram from the President which had been received and read at the meeting in the afternoon. He also read the following telegram received from the Secretary-Treasurer, Edgar Marburg:

> "Express to the American Society for Testing Materials my deep appreciation of their sympathy and good wishes and regret for my enforced absence."

The Presidential Address entitled "Engineering Societies: Their Utilities and Justification" was, in the absence of the President, read by the Vice-President, Mr. S. S. Voorhees.

The Chair then introduced Mr. R. J. Wig, Chief Engineer, Department of Concrete Ship Construction, Emergency Fleet Corporation, who gave an interesting talk on the construction of concrete ships.

On invitation of the Chair, Past-President Henry M. Howe presented a brief address.

The meeting then adjourned till the following morning and was followed by an informal reception to members, ladies and guests.

FOURTH SESSION—WEDNESDAY, JUNE 26, 10 A. M.

On Steel.

Mr. G. Aertsen in the chair.

The report of Committee A-1 on Steel was presented by its chairman, Mr. J. A. Capp. On motion of Mr. Capp the proposed revisions in the following Standard Specifications recommended in the report were referred to letter ballot of the Society for adoption as standard, with further revisions in Specifications A 28-16 and A 52-15, which had been unanimously approved by the committee at a meeting held Monday evening, June 24, as indicated below:

1. For Carbon-Steel and Alloy-Steel Forgings (A 18-16);
2. For Carbon-Steel Car and Tender Axles (A 21-14);
3. For Welded Steel and Wrought-Iron Pipe (A 53-15);
4. For Boiler and Firebox Steel for Locomotives (A 30-16);
5. For Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 19-16);
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 63-16);
7. For Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends, and Arch Tubes for Locomotive (A 28-16), as further revised;[1]
8. For Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52-15), as further revised;[2]
9. For Automobile Carbon and Alloy Steels (A 29-16).

Mr. Capp announced that the committee desired to withdraw the proposed revision in the Standard Specifications for Structural Steel for Cars (A 11-16) for further consideration. On motion this was authorized.

Mr. Capp moved that the proposed revised Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets

[1] These revisions appear in detail in an Addendum to the Report of Committee A-1, p. 129.

[2] These revisions appear in detail in an Addendum to the Report of Committee A-1, pp pp. 129-131.

and Slabs for Forgings, as appended to the report of the committee, be referred to letter ballot of the Society for adoption as standard, to replace the present Standard Specifications for Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17–13). This motion was carried with one negative vote.

On motion of Mr. Capp, the proposed revision in the Standard Specifications for Steel Tires (A 26–16), designed to correct an omission in the specifications, was unanimously referred to letter ballot of the Society for adoption as standard, with the understanding that if adopted it will be embodied in the specifications without changing their date of last revision.

On motion of Mr. Capp, the following tentative specifications were referred to letter ballot of the Society for adoption as standard:

For Steel Track Spikes (A 65–16 T);
For Steel Screw Spikes (A 66–16 T);
For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T);
For Elliptical Steel Springs for Automobiles (A 69–16 T).

On motion of Mr. Capp, the Tentative Specifications for Steel Tie Plates (A 67–17 T) in their proposed revised form as indicated in the report of the committee, were continued as tentative.

Mr. Capp moved, in pursuance of unanimous action taken at the meeting of the committee on Monday evening, that the following revision be made in the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T) and the specifications continued as tentative:

Section 6 (a).—Add the following phrase modifying the requirements that the minimum elongation in 8 in. for flange and firebox steel shall be $\frac{1{,}500{,}000}{\text{Tens. str.}}$:

"But for firebox steel not less than 24 per cent, subject to the modifications of Section 7."

This motion was unanimously carried.

On motion of Mr. Capp, the Tentative Specifications for Carbon Tool Steel (A 71–17 T) were continued as tentative with-

out amendment, and the following two proposed tentative specifications were accepted for publication among the tentative standards of the Society:

Proposed Tentative Specifications for Electric Cast Steel Anchor Chain;

Proposed Tentative Specifications for Low-Carbon-Steel Track Bolts.

On motion of Mr. Capp, the reports of Sub-Committee I dealing with the Rail Situation, and of Sub-Committee XII dealing with Ladle Test Ingots, were accepted for publication in the Proceedings as appendices to the report.[1]

Mr. Capp then reported that the committee at its meeting Monday evening had given careful consideration to the difficulty now existing under the stress of war conditions in securing an adequate supply of materials under the standard specifications for steel adopted by the Society. While at its January meeting, as stated in its report, the committee considered it more desirable "for variations from these specifications to be arranged between the manufacturer and the purchaser as applying to individual cases than for the Society to make general changes in the specifications under the present existing conditions," it had carefully reconsidered its position and by unanimous vote at its meeting Monday evening had adopted the following resolution:

> "Committee A-1 recommends to the Society that the following note be printed on certain steel specifications:
>
> "In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulfur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society."

In pursuance of unanimous action of the committee, Mr. Capp accordingly moved that this note be inserted under the titles of the following standard and tentative specifications, with the understanding (1) that the insertion of the note is not to

[1] It was not found possible to include the report of Sub-Committee XII in the Proceedings. See footnote on p. 112.

be considered as a revision of the specifications in the sense that it will need to be referred to letter ballot, and therefore that the date of last revision of the specifications is not to be changed by the addition of this note *per se;* and (2) that in the case of those specifications which do not contain requirements as to sulfur, the words "for sulfur in all steels and" will be eliminated from the note:

Standard Specifications for:

Carbon-Steel Rails (A 1–14);
Open-hearth Steel Girder and High Tee Rails (A 2–12);
Low-Carbon-Steel Splice Bars (A 3–14);
Medium-Carbon-Steel Splice Bars (A 4–14);
High-Carbon-Steel Splice Bars (A 5–14);
Extra-High-Carbon-Steel Splice Bars (A 6–14);
Quenched High-Carbon-Steel Splice Bars (A 49–15);
Quenched Carbon-Steel Track Bolts (A 50–16);
Quenched Alloy-Steel Track Bolts (A 51–16);
Structural Steel for Bridges (A 7–16);
Structural Nickel Steel (A 8–16);
Structural Steel for Buildings, (A 9–16);
Structural Steel for Locomotives (A 10–16);
Structural Steel for Ships (A 12–16);
Rivet Steel for Ships (A 13–14);
Carbon-Steel Bars for Railway Springs (A 14–16);
Carbon-Steel Bars for Vehicle and Automobile Springs (A 58–16);
Silico-Manganese-Steel Bars for Automobile and Railway Springs (A 59–16);
Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (A 60–16);
Billet-Steel Concrete Reinforcement Bars (A 15–14);
Blooms, Billets, and Slabs for Carbon-Steel Forgings (A 17–13);
Carbon-Steel and Alloy-Steel Forgings (A 18–16);
Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars (A 19–16);
Carbon-Steel Forgings for Locomotives (A 20–16);
Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 63–16);

Standard Specifications for:

Cold-Rolled Steel Axles (A 22–16);

Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57–16);

Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–16);

Steel Tires (A 26–16);

Steel Castings (A 27–16);

Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends, and Arch Tubes for Locomotives (A 28–16);

Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15);

Automobile Carbon and Alloy Steels (A 29–16);

Cold-Drawn Bessemer Steel Automatic Screw Stock (A 32–14);

Cold-Drawn Open-hearth Steel Automatic Screw Stock (A 54–15).

Tentative Specifications for:

Steel Tie Plates (A 67–17 T);

Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T);

Carbon Tool Steel (A 71–17 T);

Low-Carbon-Steel Track Bolts.

This motion was unanimously carried.

Mr. Capp then moved that the note with all reference to sulfur eliminated be printed under the Standard Specifications for Carbon-Steel Car and Tender Axles (A 21–14). This motion was unanimously carried.

Mr. Capp then moved that the note apply to the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T), calling attention to the fact that the vote of the committee on this motion was 12 affirmative, 5 negative. The motion was unanimously carried.

Mr. Capp moved that the note be added to the Standard Specifications for Structural Steel for Cars (A 11–16), calling attention to the fact that the vote of the committee on this motion was 9 affirmative, 4 negative. Mr. H. E. Smith moved

to amend this by placing the rejection limit of sulfur on check analysis at 0.06 per cent. This motion was subsequently withdrawn by Mr. Smith.

After discussion the original motion was put to a vote and carried. A division being called for, the vote was recorded as 38 affirmative, 14 negative.

Mr. Capp then stated that the committee had been unable to reach a decision with respect to applying this note to the Specifications for Boiler and Firebox Steel for Locomotives (A 30-16), a motion to add the note to these specifications having resulted in a tie vote in the committee of 10 affirmative, 10 negative.

Mr. H. E. Smith moved that the note shall not be applied to these specifications. This motion was lost by a vote of 24 affirmative, 28 negative.

Mr. A. L. Colby then moved that the note shall be added to these specifications. After considerable discussion, the motion was lost by unanimous vote.

Mr. Capp then called attention to the fact that the committee had also been unable to reach a decision with respect to applying this note to Standard Specifications for Boiler Rivet Steel (A 31-14), a motion to add the note to these specifications having resulted in a tie vote in the committee of 9 affirmative, 9 negative.

No motion was made from the floor with respect to applying the note to these specifications and the Chair accordingly ruled that it would be understood that the specifications should stand unaltered as printed in the 1916 Book of A.S.T.M. Standards.

Mr. Capp then moved that the note apply to the Specifications for Iron and Steel Chain (A 56-15), explaining that the committee through an oversight had failed to act on this specification. The motion was unanimously carried.

The report of Committee A-6 on Magnetic Properties was presented by its chairman, Mr. C. W. Burrows. On motion of Mr. Burrows, the revisions in the Standard Tests for Magnetic Properties of Iron and Steel (A 34-14) were referred to letter ballot of the Society for adoption as standard.

The report of Committee A-5 on Corrosion of Iron and Steel was presented by its chairman, Mr. S. S. Voorhees. Mr. Voorhees called upon Mr. J.H. Gibboney to present the report

of the Sub-Committee on Inspection of the Fort Sheridan, Pittsburgh and Annapolis Tests, which was then discussed.

Mr. Voorhees called the attention of the meeting to the death under tragic circumstances of one of the members of the committee, Mr. Robert B. Carnahan, Jr., and read a resolution which the committee had adopted and desired to append to its report. On motion of Mr. A. A. Stevenson, this resolution was accepted as an appendix to the report of the committee and ordered spread upon the minutes of the meeting as follows:

Resolved, That this Committee desires to record the consternation and deep regret felt by it at the news of the accidental and tragic death on the very eve of his departure to attend our annual meeting, of its long-time member and co-worker, Robert B. Carnahan, Jr., of the American Rolling Mill Company.

The enthusiasm and ability displayed by Dr. Carnahan throughout his active career, in the study and development of metallurgical problems connected with the use of the open-hearth furnace in the iron and steel industry, have made a deep impress upon the tendency of American metallurgy and will not soon be forgotten.

This committee fully understanding the contributions to metallurgy made by Dr. Carnahan and their trend and influence on the study and progress of the special problems which engaged his enthusiastic efforts, hereby recognize his contributions and records its appreciation of them. Therefore be it further

Resolved, That this appreciation be spread upon the minutes of this committee for presentation in its report to the Society; and be it also further

Resolved, That a copy of this resolution be sent to Mrs. Robert B. Carnahan and also to the President of the American Rolling Mill Company.

A motion picture, prepared by Mr. H. F. Moore at the University of Illinois, showing motion photomicrographs of Fatigue Failure of Wrought Iron was, in Mr. Moore's absence, shown by Mr. A. N. Talbot.

Owing to the lateness of the hour, it was on motion decided to defer the presentation of the remaining papers in this session until the Sixth Session on the following morning at 9.30 A. M.

The meeting then adjourned till 8 P. M.

FIFTH SESSION—WEDNESDAY, JUNE 26, 8 P. M.

Cooperation in Industrial Research.

Past-President A. A. Stevenson in the chair.

The Chair announced that at the request of the Executive Committee, Mr. Albert Ladd Colby, who represented the Society at an Anglo-American Aircraft Conference in London early in the present year, would present a brief report of his work on steel specifications at that conference.

Following the presentation of Mr. Colby's report, the Topical Discussion on Cooperation in Industrial Research was introduced by the reading by the Assistant to the Secretary of an "Opening Announcement" prepared by the Secretary-Treasurer, Mr. Edgar Marburg, and was formally opened by the presentation of the following five papers:

"General Introduction" by Mr. Henry M. Howe;
"Recent Developments in Great Britain" by Mr. John Johnston;
"Organization of Industrial Research" by Mr. Arthur D. Little;
"Developments in Industrial Research" by Mr. Charles L. Reese;
"Cooperative Research in the American Canning Industry" by Mr. Frank E. Gorrell, presented in Mr. Gorrell's absence by Mr. W. D. Bigelow.

The discussion was then continued by the presentation of the following contributions:

"Development of Existing Agencies" by Mr. Alfred D. Flinn;
"Some Practical Views of Research" by Mr. J. S. Unger;
"Cooperation of the Portland Cement Association and Lewis Institute in Experimental Studies of Concrete" by Mr. D. A. Abrams.

The meeting then adjourned till the following morning.

SIXTH SESSION—THURSDAY, JUNE 27, 9.30 A. M.

On Preservative Coatings and Non-Ferrous Metals.

Mr. W. H. Bassett in the chair.

A paper on "Cast Steel Anchor Chain" was presented by the author, Mr. H. Jasper Cox. The discussion of the paper was formally opened by Mr. W. L. Merrill and Mr. Chester K. Brooks.

A paper entitled "Grain Size of Iron as Affected by Temperature" was presented by its author, Mr. D. J. McAdam, Jr., and discussed.

A paper by Mr. J. G. Ayers, Jr., entitled "Changes within the Critical Range of a Given Steel: From Ac_1 to Ac_{3-2}" was, in the absence of the author, read by title.

The Chair then announced that the Executive Committee desired to present an important matter to the Society for its consideration.

The Assistant to the Secretary stated that at its meeting on Wednesday afternoon, June 26, the Executive Committee, as announced in its report, had given careful consideration to the participation of the American Society for Testing Materials as one of the founder societies in the organization of a proposed American Engineering Standards Committee as outlined in the Constitution and Rules of Procedure of such a Committee submitted by the organization committee, consisting of three representatives from each of the proposed five founder societies, namely, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society for Testing Materials. He stated that the Executive Committee had approved the scheme of organization as proposed in the Constitution and Rules of Procedure, and requested Mr. J. A. Capp, one of the representatives of the Society on the organization committee, to speak more fully on the proposed scheme of organization.

Mr. Capp then summarized briefly the method of procedure under the proposed American Engineering Standards Committee. He explained that at present there are many bodies engaged in the formulation of standards, that there is no uniform-

ity in the rules for such procedure in the different organizations, and that the present custom results in considerable duplication of work. It has accordingly seemed fitting that the five national engineering societies mentioned above, together with three Government Departments, namely, the Department of Commerce, the War Department and the Navy Department, should exercise a supervision over the way in which standardization should be accomplished by technical societies in general, through an American Engineering Standards Committee. Membership in the Committee will be vested in these founder societies and in the three Government departments, if the latter accept the invitation to participate. The proposed Constitution and Rules of Procedure provide briefly that the work of standardization shall be delegated to "Cooperating Societies"—not necessarily one of the founder societies—who shall stand as sponsor or joint sponsor for the standards whose preparation has been entrusted to them. The sponsors organize "Sectional Committees," whose personnel must conform to certain requirements in the Rules of Procedure, Sectional committees report to their sponsor society who, if they approve the standard, may then offer it to the Engineering Standards Committee. The function of this Committee is then simply to see that the necessary regulations governing the preparation of the standard have been observed, when by a certain restricted vote of the Committee it may become a "Tentative Standard" or "Recommended Practice," and later, after approval by the sponsor society, and again by a restricted vote of the Committee, it may become an "American Standard."

Mr. Capp then illustrated this method of procedure by showing how an A.S.T.M. standard would finally become an "American standard." He also pointed out that the Rules of Procedure are based largely upon the present method of conducting the committee work of this Society.

Mr. Capp then moved that the following resolution be referred to letter ballot vote of the Society:

> *Resolved,* That the American Society for Testing Materials approves the scheme of organization of the proposed American Engineering Standards Committee, as outlined in the Constitution and Rules of Procedure sub-

mitted, and agrees to participate as a founder, as recommended by the Executive Committee.

This motion was unanimously carried.[1]

(NOTE.—The Constitution and Rules of Procedure of the proposed American Engineering Standards Committee referred to in the above motion are presented in Appendix II to this Summary of the Proceedings.)

The report of Committee D-1 on Preservative Coatings for Structural Materials was presented by its chairman, Mr. P. H. Walker. On motion of Mr. Walker, the Tentative Methods for Routine Analysis of Dry Red Lead (D 49–17 T) and the Tentative Methods for Routine Analysis of Yellow, Orange, Red and Brown Pigments containing Iron and Manganese (D 50–17T) were referred to letter ballot of the Society for adoption as standard.

On motion of Mr. Walker, the proposed Tentative Specifications for Foots Permissible in Properly Clarified Pure Raw Linseed Oil from North American Seed, and the proposed Tentative Test for Flash Point of Paint Thinners other than Turpentine, were accepted for publication among the tentative standards of the Society.

Mr. Walker then presented certain minor amendments to the report of Sub-Committee XIV on the Preparation of Iron and Steel Surfaces for Painting. On motion, the report as amended was accepted for publication in the Proceedings of the Society.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was presented by its chairman, Mr. William Campbell. On motion of Mr. Campbell, the following tentative specifications, amended as indicated in the report of the committee, were referred to letter ballot of the Society for adoption as standard:

For Spelter (B 6–17 T);
For Copper Plates for Locomotive Fireboxes (B 11–16 T);
For Copper Bars for Locomotive Staybolts (B 12–16 T);
For Seamless Copper Boiler Tubes (B 13–16 T);
For Seamless Brass Boiler Tubes (B 14–16 T);
For Brass Forging Rod (B 15–17 T);

[1] The resolution referred to was adopted by letter ballot of the Society on August 26, 1918. —ED.

For Free-Cutting Brass Rod for Use in Screw Machines (B 16–17 T), in its proposed amended form as recommended by the committee.

Mr. Campbell then moved that the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent, Zinc, 2 per cent (B 10–15 T) as amended in the report of the committee, be further amended by eliminating the proposed new requirement that the yield point shall be 15,000 lb. per sq. in., and referred in its finally amended form to letter ballot of the Society for adoption as standard. This motion was unanimously carried.

On motion of Mr. Campbell, the following proposed new tentative specifications and methods were accepted for publication among the tentative standards of the Society:

For Cartridge Brass;
For Cartridge Brass Disks;
For Naval Brass Rods for Structural Purposes;
For Bronze Bearing Metals for Turntables and Movable Railroad Bridges, with certain revisions in the requirements for chemical composition and physical properties;
For White Metal Bearing Alloys (Babbitt Metals);
For Chemical Analysis of Manganese Bronze;
For Chemical Analysis of Gun Metal.

On motion of Mr. Campbell, the following three proposed tentative specifications were accepted for publication among the tentative standards of the Society, provided that a subsequent letter ballot of Committee B-2 on these specifications should be carried without a dissenting vote, these items not having previously been submitted to letter ballot of the committee, as required by the Regulations Governing Standing Committees:[1]

For Aluminum Ingots for Remelting and for Rolling;
For Aluminum Sheet;
For Light Aluminum Casting Alloys.

Mr. Campbell then called attention to the proposed revisions in the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment in Ingots, Castings and Finished Car and

[1] The subsequent vote oy letter ballot of Committee B-2 was affirmative without a dissenting vote, and the three tentative specifications are therefore printed in these Proceedings, pp. 492–501.

Tender Bearings (B 17–17 T) contained in its report, and stated that at a meeting of the committee held the previous afternoon it had been decided to recommend that the maximum percentages of total impurities in the proposed new bearing metals Nos. 1 and 2 be changed from 1 and 1.5 to 1.5 and 2 per cent, respectively. Mr. Campbell moved that the specifications as thus amended be continued as tentative for another year. After considerable discussion this motion was lost.

Mr. E. J. Edwards then moved that the specifications in their present tentative form as printed in the 1917 Proceedings be continued as tentative, and that the committee be requested to give further consideration to the revisions proposed in its report.

Mr. J. A. Capp moved to amend this motion by continuing the specifications as tentative in their proposed revised form as recommended by the committee in its printed report, without the further proposed revision relating to impurities. This amendment was accepted by Mr. Edwards and the motion as amended was unanimously carried.

At the request of a number of interested persons the motion photomicrographs of Fatigue Failure of Wrought Iron, prepared by Mr. H. F. Moore, were again shown.

As a special order of business, Mr. H. E. Diller, chairman of the newly organized Committee A-7 on Malleable Castings, presented proposed Tentative Specifications for Malleable Castings on behalf of that committee. He explained that they were to supersede the present Tentative Specifications for Railroad Malleable-Iron Castings (A 75–17 T) and that they had not yet been submitted to letter ballot of the committee, having been acted upon at a meeting of the committee the previous day. On motion of Mr. Diller, the proposed specifications were accepted for publication among the tentative standards of the Society, provided that a subsequent letter ballot of Committee A-7 on these specifications should be carried without a dissenting vote.[1]

A paper entitled "The Evaluation of Zinc Dust: A Proposed Method of Analysis" was presented by its author, Mr. L. A. Wilson.

A Topical Discussion on Season and Corrosion Cracking

[1] The subsequent vote by letter ballot of Committee A-7 was affirmative without a dissenting vote, and the tentative specifications are therefore printed in these Proceedings, pp. 464–466.

of Brass was formally introduced by the presentation of the following five papers:

"Season Cracking and Splitting of Tubes and Pipes" by Mr. William Campbell;

"The Causes and Prevention of Corrosion Cracking" by Mr. W. H. Bassett;

"Season Cracking" by Mr. W. Reuben Webster, read by title in Mr. Webster's absence;

"Initial Stress and Corrosion Cracking" by Mr. P. D. Merica and Mr. W. R. Woodward, presented by Mr. Woodward;

"The Prevention of Season and Corrosion Cracking of Brass Artillery Cases by Special Heat Treatment" by Mr. W. B. Price.

A written discussion by Mr. H. S. Rawdon was, in his absence, presented by Mr. R. W. Woodward.

Written discussions by Messrs. A. D. Flinn and Ernst Jonson, and Mr. R. C. Becker, were read by title in the absence of the authors.

The discussion was then thrown open to the meeting.

The meeting then adjourned till 8 P. M.

SEVENTH SESSION—THURSDAY, JUNE, 27, 8 P. M.

Joint Session with the American Concrete Institute on Cement and Concrete.

Mr. Robert W. Lesley in the chair.

On the invitation of the Chair, Mr. E. D. Boyer, chairman of the Golf Tournament Committee, awarded the following prizes as a result of the tournament held Thursday afternoon:

For Low Score for the Course:

The American Society for Testing Materials Championship Cup and a medal: Mr. Robert E. Griffith, Philadelphia, Pa.

For the Lowest Net Score:

First Prize.........Mr. W. B. Price, Waterbury, Conn.
Second Prize.......Mr. E. E. Hughes, Franklin, Pa.
Third Prize.... ...Mr. R. S. MacPherran, Milwaukee, Wis.

For the winner of the "Blind Handicap:"

A silver cup........Mr. T. A. Hicks, Catasauqua, Pa.

The report of Committee C-1 on Cement was presented by its chairman, Mr. R. S. Greenman. On motion of Mr. Greenman, the Tentative Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9-16 T) were continued as tentative.

The report of Committee C-2 on Reinforced Concrete was, in the absence of its chairman, Mr. F. E. Turneaure, presented by its secretary, Mr. Richard L. Humphrey.

The report of the committee of the American Concrete Institute on the Treatment of Concrete Surfaces was presented by its chairman, Mr. J. C. Pearson.

The following two papers of the American Concrete Institute were presented by their respective authors and discussed:

"Tests of Stucco" by Mr. J. C. Pearson;

"Fire Tests of Concrete Columns" by Mr. W. A. Hull.

Vice-President S. S. Voorhees then requested that Past-President A. A. Stevenson be permitted to make a very grave announcement to the members of the Society.

Mr. Stevenson then read a telegram just received announcing the death of the Secretary-Treasurer, Mr. Edgar Marburg, on Thursday afternoon, June 27. After speaking of Doctor Marburg's faithful and effective service as Secretary-Treasurer of the Society since its incorporation in 1902, and paying tribute to his sterling character, Mr. Stevenson moved that the Vice-President be authorized to appoint a committee of three to prepare appropriate resolutions for presentation at the eighth session of the annual meeting on Friday morning. This motion was adopted by a rising vote and Mr. Voorhees announced the appointment of Past-Presidents A. N. Talbot, A. A. Stevenson and Henry M. Howe.

The following papers were then introduced by their respective authors and discussed:

"Effect of Age on the Strength of Concrete" by Mr. D. A. Abrams;

"Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates" by Mr. L. N. Edwards.

The meeting then adjourned till the following morning.

EIGHTH SESSION—FRIDAY, JUNE 28, 10 A. M.

On Lubricants and Cement.

Vice-President S. S. Voorhees in the chair.

Past-President A. N. Talbot presented the following resolution on the death of the Secretary-Treasurer, Mr. Edgar Marburg, which was unanimously adopted by a rising vote:

EDGAR MARBURG

1864 – 1918.

The American Society for Testing Materials in annual meeting assembled learns with profound sorrow of the death of its esteemed Secretary-Treasurer, Edgar Marburg, on June 27, 1918.

In this hour of bereavement, the Society desires to place on its records an acknowledgment of the great debt which it owes to Edgar Marburg. By zeal, industry, loyalty, insight and high ability exerted through sixteen years as Secretary-Treasurer of the Society; by guiding its actions, energizing its activities, and guarding its name, he has exercised a powerful influence on the character, standing and usefulness of the Society, and on the making of specifications and tests for the materials of engineering. He is honored and revered as a master and leader. The imprint of his work will long remain.

The Society extends to the family heartfelt sympathy for their great loss. May the knowledge that his fine character, strong manhood, and great work in the field of engineering are appreciated by the membership of the American Society for Testing Materials become a part of their many treasured memories of his life and work.

On motion of Past-President Stevenson, the Executive Committee was authorized to have this resolution engrossed and presented to the family.

At the request of the Vice-President, Mr. P. H. Walker now assumed the chair.

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SUMMARY OF THE PROCEEDINGS OF THE TWENTY-FIRST ANNUAL MEETING.

Atlantic City, N. J., June 25–28, 1918.

The Twenty-first Annual Meeting of the American Society for Testing Materials was held at the Hotel Traymore, Atlantic City, N. J., June 25–28, 1918. The following is an analysis of attendance at the meeting: Members in attendance or represented 475; guests, 129; total, 604; ladies, 108. The corresponding statistics for the Twentieth Annual Meeting are: Members in attendance or represented, 507; guests, 90; total, 597; ladies, 154.

The names of the members who were present or represented are given in Appendix I to this Summary.

First Session—Tuesday, June 25, 10 a. m.

Vice-President S. S. Voorhees in the chair.

The Vice-President explained that the President, Gen. W. H. Bixby, was unavoidably absent on account of his connection with Government work, and at his request the following letter from the President was read:

St. Louis, Mo., June 16, 1918.

Messrs. A. A. Stevenson and A. W. Gibbs,
Past-Presidents and Members of the Executive Committee,
American Society for Testing Materials, Philadelphia, Pa.

My dear Mr. Stevenson and Mr. Gibbs:

Up to within the last few days, I have been hoping and even expecting that I should be able to attend the coming annual meeting of the Society and preside thereat. But, instead of my work lessening, it has been increasing. Moreover, Congress has not made the expected progress in its appropriation bills (River and Harbor, and Sundry Civil bills) connected with the work of my Division and the Mississippi River Commission; and until they are passed, I have to be here on hand to make special reports on immediate telegraphic calls from the Engineer Department or from the Congressional Committees or perhaps both. More than this, I assume that you have seen

in the papers recently that the Chief of Engineers has just started to organize and commission several more regiments of engineer troops; so that daily I am called upon to examine and commission (or rather recommend for commission) officers who are being called to immediate service with troops expected to start immediately for the other side. I seem to be the only ex-engineer retired officer available for such examinations for the States of Arkansas, Missouri, and Iowa, and west therefrom to the Rockies. The next nearest officers so available are at Chicago, Cincinnati and New Orleans. In addition the U. S. fiscal year ends on June 30, and all sorts of reports have to come in and be passed upon during the last week of the month. All this makes it practically impossible for me to get away from my present station during the last week of the present month. I am very sorry for the unusual complications; but I do not see that they can be avoided. Consequently I feel obliged to call upon you two Past-Presidents to take charge at the coming meeting of the Society, and to act there in my place. I shall have to leave to you to decide how far the Vice-Presidents can be called upon for such service, as my understanding at present is that they are tied up by War Service at present even more effectively than myself.

Regretting the above complications, I hope that the Vice-Presidents, the Executive Committee, and the Past-Presidents, will all do that is possible to make the meeting a success.

Very truly yours,
(Signed) W. H. BIXBY,
President, A.S.T.M.

The Vice-President then referred to the absence on account of illness of the Secretary-Treasurer, Mr. Edgar Marburg.

The following resolution introduced by Past-President A. A. Stevenson was unanimously adopted by rising vote and telegraphed at once to Mr. Marburg:

> "The American Society for Testing Materials in meeting assembled express their sincere and heartfelt sympathy for their honored and worthy Secretary and wish him a speedy recovery and an early return to the duties he has so admirably and ably conducted."

On motion of Mr. Stevenson the following resolution was unanimously adopted by rising vote and telegraphed to the President:

> "The American Society for Testing Materials in meeting assembled regret that you could not be present, but appreciate the conditions and wish you success in the many duties you have undertaken in these strenuous and serious times."

The minutes of the Twentieth Annual Meeting were approved as printed.

The Vice-President appointed Mr. S. R. Church and Mr. F. N. Speller as tellers to canvass the vote for officers.

The Assistant to the Secretary presented the annual report of the Executive Committee.

The Assistant to the Secretary moved, on behalf of the Executive Committee, that the following amendment of Article II, Section 5 of the By-laws be referred to letter ballot for adoption:

Add the following new paragraph to Section 5:

"The Executive Committee shall also be empowered to elect an Assistant Secretary at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary shall be fixed by the Executive Committee."

Mr. A. A. Stevenson moved that this amendment be revised to read as follows by the insertion of the italicized words:

"The Executive Committee shall also be empowered to elect an Assistant Secretary *and an Assistant Treasurer* at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary *and Assistant Treasurer* shall be fixed by the Executive Committee."

This motion was carried and the amendment as revised was unanimously referred to letter ballot.

The Assistant to the Secretary moved, on behalf of the Executive Committee, that the following amendment to Article III, Section 2 of the By-laws be referred to letter ballot for adoption:

For the sixth sentence, which reads:

"The members of the nominating committee for the previous year shall not be eligible for appointment on this committee for the immediately succeeding year.",

substitute:

"The members of the Nominating Committee for a given year shall not be eligible for appointment on this committee for the immediately succeeding year."

Mr. A. A. Stevenson moved that this wording be revised by the elimination of the word "immediately".

This motion was carried and the amendment as revised was unanimously referred to letter ballot.

The proposed amendments of Article VI, Section 1, of the By-laws recommended by the Executive Committee were unanimously referred to letter ballot.

Mr. J. A. Capp moved that, in pursuance of its request, the Executive Committee be authorized to publish the Book of A.S.T.M. Standards in 1918 as planned, and the next one in 1921. This motion was unanimously carried.

The report of Committee E-3 on Revision of Pipe Threads was presented by Mr. J. A. Hance, representing the chairman, Mr. H. V. Wille.

The report of Committee E-5 on Standing Committees was presented by the Assistant to the Secretary in the absence of the chairman, Mr. Edgar Marburg.

The report of Committee E-4 on Magnification Scales for Micrographs was introduced by its chairman, Mr. W. H. Bassett. On motion of Mr. Bassett the proposed amendments in the Tentative Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2–17 T) were accepted and the Definitions continued as tentative.

The Assistant to the Secretary presented the report of Committee E-6 on Papers and Publications in the absence of the chairman, Mr. Edgar Marburg.

The report of Committee D-7 on Timber was presented by its chairman, Mr. Hermann von Schrenk. Mr. von Schrenk moved that the proposed Tentative Specifications for Wooden Paving Blocks be amended by adding the words "for Exposed Pavements" to the title and by adding the following new Section 1:

> "These specifications cover wooden paving blocks for pavements exposed to alternate wet and dry conditions, as distinguished from pavements which are used under cover and protected from atmospheric influences";

and that the specifications as thus amended be accepted for publication among the tentative standards of the Society.

After considerable discussion Mr. W. H. Fulweiler moved as an amendment that Sections 7 to 9 inclusive of the specifications, relating to preservative, be referred back to the committee. This amendment was lost.

Mr. A. A. Stevenson moved as an amendment that the appendix at the end of the specifications be incorporated in the specifications as a note. This amendment was adopted and the specifications as thus amended were accepted as tentative.

On motion of Mr. von Schrenk the Tentative Methods for Analysis of Creosote Oil (D 38–17 T) were referred to letter ballot of the Society for adoption as standard, to be incorporated, if adopted, in the present Standard Methods for Sampling and Analysis of Creosote Oil (D 38–17).

On motion of Mr. von Schrenk the following specifications were continued as tentative:

Tentative Specifications for Selected Structural Douglas-Fir Bridge and Trestle Timbers (D 23–16 T);

Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted (D 24–15 T);

Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted (D 25–15 T).

The report of Committee D-13 on Textile Materials was presented by its chairman, Mr. G. B. Haven, who recommended certain minor changes in the proposed revised Tentative General Methods for Testing Cotton Fabrics appended to the report. On motion of Mr. Haven, these changes were approved and the Methods accepted for publication among the tentative standards of the Society, with the understanding that they will supersede the present Tentative Methods (D 39–16 T) of that title as well as the following Tentative Tests: For Automobile Tire Fabrics (D 31–16 T); for Cotton Fabrics for Use in Hose, Belting, and Similar Articles (D 32–16 T); for Cotton Fabrics for Use in Bags and Bagging Material (D 33–16 T).

The tellers on the votes for election of officers presented their report, and in accordance therewith the Vice-President announced the election of the following officers:

For President, to serve for one year: Guilliam H. Clamer.

For Vice-President, to serve for two years: George S. Webster.

For Members of the Executive Committee, to serve for two years: Guilliaem Aertsen, C. K. Burgess, G. B. Heckel, K. W. Zimmerschied.

The Vice-President appointed Past-Presidents A. N. Talbot and A. A. Stevenson to escort the President-elect, Mr. G. H. Clamer, to the chair. Mr. Clamer expressed his appreciation of the honor conferred upon him by election to the presidency and pledged himself to the faithful discharge of his duties.

The meeting then adjourned till 3 P. M.

SECOND SESSION—TUESDAY, JUNE 25, 3 P. M.

On Wrought Iron, Cast Iron and Testing.

Mr. J. H. Gibboney in the chair.

The report of Committee A-2 on Wrought Iron was, in the absence of its chairman, Mr. H. E. Smith, presented by the secretary, Mr. J. B. Young.

Mr. Young moved that the proposed revisions in the Standard Specifications for Lap-Welded Charcoal-Iron Boiler Tubes, Boiler Flues, Safe Ends, and Arch Tubes for Locomotives (A 38–16) contained in the report be referred to letter ballot of the Society for adoption as standard, as well as certain additional revisions in Section 11 on Workmanship. [1]

This motion was unanimously carried.

On motion of Mr. Young the proposed revisions in the following specifications were unanimously referred to letter ballot of the Society for adoption as standard:

For Engine-Bolt Iron (A 40–13);
For Refined Wrought-Iron Bars (A 41–13);
For Wrought-Iron Plates (A 42–13);
For Iron and Steel Chain (A 56–15).

On motion of Mr. Young, the following Tentative Standards, revised as indicated in the report of the committee, were unanimously referred to letter ballot of the Society for adoption as standard:

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[1] These revisions appear in detail in an Addendum to the Report of Committee A-2, p. 155.

For Staybolt Iron (A 39–17 T)—to replace, if adopted, the present Standard Specifications for Staybolt Iron (A 39–14);

For Wrought-Iron Pipe (A 72–17 T);

For Wrought-Iron Rolled or Forged Blooms and Forgings for Locomotives and Cars (A 73–17 T).

The report of Committee A-3 on Cast Iron was presented by its chairman, Mr. Richard Moldenke. On motion of Mr. Moldenke, the Tentative Specifications for Cast-Iron Soil Pipe and Fittings (A 74–17 T) and the proposed revision in the Standard Specifications for Gray-Iron Castings (A 48–05), were unanimously referred to letter ballot of the Society for adoption as standard.

The recommendation of the committee that the Tentative Specifications for Railroad Malleable-Iron Castings (A 75–17 T) be referred to letter ballot for adoption as standard, was, on motion of Mr. Moldenke, withdrawn from the report and the specifications were placed in the charge of the newly organized Committee A-7 on Malleable Castings.[1]

The report of Committee E-1 on Methods of Testing was introduced by its chairman, Mr. G. Lanza. On motion of Mr. Lanza, the proposed revisions in the Standard Methods for Testing (E 1–16) were referred to letter ballot of the Society for adoption as standard.

A paper on "A Simple Type of Brinell Testing Machine for 500 kg. Load" was presented by the author, Mr. A. V. de Forest.

A paper entitled "A New Method of Obtaining Brinell Hardness" by Mr. J. G. Ayers, Jr., was, in the absence of the author, read by title and discussed jointly with the preceding paper.

The following papers were then presented by their respective authors:

"Effect of Moisture on the Tensile Strength of Aircraft Fabrics" by Mr. G. B. Haven.[2]

"Transverse Testing Under Non-Uniformly Distributed

[1] For report of this committee, see p. 29.

[2] This paper is published as an Appendix to the report of Committee D-13 on Textile Materials. See p. 380.

Load with Special Application to Airplane Wing Ribs" by Mr. I. H. Cowdrey.

A paper on "Sumner Elastic-Limit Recorder" by Mr. J. L. Jones and Mr. C. H. Marshall, was presented by Mr. Dean Harvey.

The Assistant to the Secretary read the following telegram from President Bixby:

> "Present to the Society my sincere regrets at inability to be present, and my best wishes for a successful and enjoyable meeting."

The meeting then adjourned till 8 P. M.

THIRD SESSION—TUESDAY, JUNE 25, 8 P. M.

Vice-President S. S. Voorhees in the chair.

For the information of the members and guests present, the Chair read the resolutions which had been adopted at the first session and telegraphed to President Bixby and Secretary-Treasurer Marburg, and the telegram from the President which had been received and read at the meeting in the afternoon. He also read the following telegram received from the Secretary-Treasurer, Edgar Marburg:

> "Express to the American Society for Testing Materials my deep appreciation of their sympathy and good wishes and regret for my enforced absence."

The Presidential Address entitled" Engineering Societies: Their Utilities and Justification" was, in the absence of the President, read by the Vice-President, Mr. S. S. Voorhees.

The Chair then introduced Mr. R. J. Wig, Chief Engineer, Department of Concrete Ship Construction, Emergency Fleet Corporation, who gave an interesting talk on the construction of concrete ships.

On invitation of the Chair, Past-President Henry M. Howe presented a brief address.

The meeting then adjourned till the following morning and was followed by an informal reception to members, ladies and guests.

FOURTH SESSION—WEDNESDAY, JUNE 26, 10 A. M.

On Steel.

Mr. G. Aertsen in the chair.

The report of Committee A-1 on Steel was presented by its chairman, Mr. J. A. Capp. On motion of Mr. Capp the proposed revisions in the following Standard Specifications recommended in the report were referred to letter ballot of the Society for adoption as standard, with further revisions in Specifications A 28–16 and A 52–15, which had been unanimously approved by the committee at a meeting held Monday evening, June 24, as indicated below:

1. For Carbon-Steel and Alloy-Steel Forgings (A 18–16);
2. For Carbon-Steel Car and Tender Axles (A 21–14);
3. For Welded Steel and Wrought-Iron Pipe (A 53–15);
4. For Boiler and Firebox Steel for Locomotives (A 30–16);
5. For Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 19–16);
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 63–16);
7. For Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends, and Arch Tubes for Locomotive (A 28–16), as further revised;[1]
8. For Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15), as further revised;[2]
9. For Automobile Carbon and Alloy Steels (A 29–16).

Mr. Capp announced that the committee desired to withdraw the proposed revision in the Standard Specifications for Structural Steel for Cars (A 11–16) for further consideration. On motion this was authorized.

Mr. Capp moved that the proposed revised Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets

[1] These revisions appear in detail in an Addendum to the Report of Committee A-1, p. 129.

[2] These revisions appear in detail in an Addendum to the Report of Committee A-1,pp pp. 129–131.

and Slabs for Forgings, as appended to the report of the committee, be referred to letter ballot of the Society for adoption as standard, to replace the present Standard Specifications for Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17–13). This motion was carried with one negative vote.

On motion of Mr. Capp, the proposed revision in the Standard Specifications for Steel Tires (A 26–16), designed to correct an omission in the specifications, was unanimously referred to letter ballot of the Society for adoption as standard, with the understanding that if adopted it will be embodied in the specifications without changing their date of last revision.

On motion of Mr. Capp, the following tentative specifications were referred to letter ballot of the Society for adoption as standard:

For Steel Track Spikes (A 65–16 T);
For Steel Screw Spikes (A 66–16 T);
For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T);
For Elliptical Steel Springs for Automobiles (A 69–16 T).

On motion of Mr. Capp, the Tentative Specifications for Steel Tie Plates (A 67–17 T) in their proposed revised form as indicated in the report of the committee, were continued as tentative.

Mr. Capp moved, in pursuance of unanimous action taken at the meeting of the committee on Monday evening, that the following revision be made in the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T) and the specifications continued as tentative:

Section 6 (*a*).—Add the following phrase modifying the requirements that the minimum elongation in 8 in. for flange and firebox steel shall be $\frac{1{,}500{,}000}{\text{Tens. str.}}$:

"But for firebox steel not less than 24 per cent, subject to the modifications of Section 7."

This motion was unanimously carried.

On motion of Mr. Capp, the Tentative Specifications for Carbon Tool Steel (A 71–17 T) were continued as tentative with-

out amendment, and the following two proposed tentative specifications were accepted for publication among the tentative standards of the Society:

Proposed Tentative Specifications for Electric Cast Steel Anchor Chain;

Proposed Tentative Specifications for Low-Carbon-Steel Track Bolts.

On motion of Mr. Capp, the reports of Sub-Committee I dealing with the Rail Situation, and of Sub-Committee XII dealing with Ladle Test Ingots, were accepted for publication in the Proceedings as appendices to the report.[1]

Mr. Capp then reported that the committee at its meeting Monday evening had given careful consideration to the difficulty now existing under the stress of war conditions in securing an adequate supply of materials under the standard specifications for steel adopted by the Society. While at its January meeting, as stated in its report, the committee considered it more desirable "for variations from these specifications to be arranged between the manufacturer and the purchaser as applying to individual cases than for the Society to make general changes in the specifications under the present existing conditions," it had carefully reconsidered its position and by unanimous vote at its meeting Monday evening had adopted the following resolution:

> "Committee A-1 recommends to the Society that the following note be printed on certain steel specifications:
>
> "In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulfur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society."

In pursuance of unanimous action of the committee, Mr. Capp accordingly moved that this note be inserted under the titles of the following standard and tentative specifications, with the understanding (1) that the insertion of the note is not to

[1] It was not found possible to include the report of Sub-Committee XII in the Proceedings. See footnote on p. 112.

be considered as a revision of the specifications in the sense that it will need to be referred to letter ballot, and therefore that the date of last revision of the specifications is not to be changed by the addition of this note *per se;* and (2) that in the case of those specifications which do not contain requirements as to sulfur, the words "for sulfur in all steels and" will be eliminated from the note:

Standard Specifications for:

Carbon-Steel Rails (A 1–14);
Open-hearth Steel Girder and High Tee Rails (A 2–12);
Low-Carbon-Steel Splice Bars (A 3–14);
Medium-Carbon-Steel Splice Bars (A 4–14);
High-Carbon-Steel Splice Bars (A 5–14);
Extra-High-Carbon-Steel Splice Bars (A 6–14);
Quenched High-Carbon-Steel Splice Bars (A 49–15);
Quenched Carbon-Steel Track Bolts (A 50–16);
Quenched Alloy-Steel Track Bolts (A 51–16);
Structural Steel for Bridges (A 7–16);
Structural Nickel Steel (A 8–16);
Structural Steel for Buildings, (A 9–16);
Structural Steel for Locomotives (A 10–16);
Structural Steel for Ships (A 12–16);
Rivet Steel for Ships (A 13–14);
Carbon-Steel Bars for Railway Springs (A 14–16);
Carbon-Steel Bars for Vehicle and Automobile Springs (A 58–16);
Silico-Manganese-Steel Bars for Automobile and Railway Springs (A 59–16);
Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (A 60–16);
Billet-Steel Concrete Reinforcement Bars (A 15–14);
Blooms, Billets, and Slabs for Carbon-Steel Forgings (A 17–13);
Carbon-Steel and Alloy-Steel Forgings (A 18–16);
Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars (A 19–16);
Carbon-Steel Forgings for Locomotives (A 20–16);
Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 63–16);

Standard Specifications for:

Cold-Rolled Steel Axles (A 22–16);
Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57–16);
Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–16);
Steel Tires (A 26–16);
Steel Castings (A 27–16);
Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends, and Arch Tubes for Locomotives (A 28–16);
Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15);
Automobile Carbon and Alloy Steels (A 29–16);
Cold-Drawn Bessemer Steel Automatic Screw Stock (A 32–14);
Cold-Drawn Open-hearth Steel Automatic Screw Stock (A 54–15).

Tentative Specifications for:

Steel Tie Plates (A 67–17 T);
Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T);
Carbon Tool Steel (A 71–17 T);
Low-Carbon-Steel Track Bolts.

This motion was unanimously carried.

Mr. Capp then moved that the note with all reference to sulfur eliminated be printed under the Standard Specifications for Carbon-Steel Car and Tender Axles (A 21–14). This motion was unanimously carried.

Mr. Capp then moved that the note apply to the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T), calling attention to the fact that the vote of the committee on this motion was 12 affirmative, 5 negative. The motion was unanimously carried.

Mr. Capp moved that the note be added to the Standard Specifications for Structural Steel for Cars (A 11–16), calling attention to the fact that the vote of the committee on this motion was 9 affirmative, 4 negative. Mr. H. E. Smith moved

to amend this by placing the rejection limit of sulfur on check analysis at 0.06 per cent. This motion was subsequently withdrawn by Mr. Smith.

After discussion the original motion was put to a vote and carried. A division being called for, the vote was recorded as 38 affirmative, 14 negative.

Mr. Capp then stated that the committee had been unable to reach a decision with respect to applying this note to the Specifications for Boiler and Firebox Steel for Locomotives (A 30–16), a motion to add the note to these specifications having resulted in a tie vote in the committee of 10 affirmative, 10 negative.

Mr. H. E. Smith moved that the note shall not be applied to these specifications. This motion was lost by a vote of 24 affirmative, 28 negative.

Mr. A. L. Colby then moved that the note shall be added to these specifications. After considerable discussion, the motion was lost by unanimous vote.

Mr. Capp then called attention to the fact that the committee had also been unable to reach a decision with respect to applying this note to Standard Specifications for Boiler Rivet Steel (A 31–14), a motion to add the note to these specifications having resulted in a tie vote in the committee of 9 affirmative, 9 negative.

No motion was made from the floor with respect to applying the note to these specifications and the Chair accordingly ruled that it would be understood that the specifications should stand unaltered as printed in the 1916 Book of A.S.T.M. Standards.

Mr. Capp then moved that the note apply to the Specifications for Iron and Steel Chain (A 56–15), explaining that the committee through an oversight had failed to act on this specification. The motion was unanimously carried.

The report of Committee A-6 on Magnetic Properties was presented by its chairman, Mr. C. W. Burrows. On motion of Mr. Burrows, the revisions in the Standard Tests for Magnetic Properties of Iron and Steel (A 34–14) were referred to letter ballot of the Society for adoption as standard.

The report of Committee A-5 on Corrosion of Iron and Steel was presented by its chairman, Mr. S. S. Voorhees. Mr. Voorhees called upon Mr. J.H. Gibboney to present the report

of the Sub-Committee on Inspection of the Fort Sheridan, Pittsburgh and Annapolis Tests, which was then discussed.

Mr. Voorhees called the attention of the meeting to the death under tragic circumstances of one of the members of the committee, Mr. Robert B. Carnahan, Jr., and read a resolution which the committee had adopted and desired to append to its report. On motion of Mr. A. A. Stevenson, this resolution was accepted as an appendix to the report of the committee and ordered spread upon the minutes of the meeting as follows:

Resolved, That this Committee desires to record the consternation and deep regret felt by it at the news of the accidental and tragic death on the very eve of his departure to attend our annual meeting, of its long-time member and co-worker, Robert B. Carnahan, Jr., of the American Rolling Mill Company.

The enthusiasm and ability displayed by Dr. Carnahan throughout his active career, in the study and development of metallurgical problems connected with the use of the open-hearth furnace in the iron and steel industry, have made a deep impress upon the tendency of American metallurgy and will not soon be forgotten.

This committee fully understanding the contributions to metallurgy made by Dr. Carnahan and their trend and influence on the study and progress of the special problems which engaged his enthusiastic efforts, hereby recognize his contributions and records its appreciation of them. Therefore be it further

Resolved, That this appreciation be spread upon the minutes of this committee for presentation in its report to the Society; and be it also further

Resolved, That a copy of this resolution be sent to Mrs. Robert B. Carnahan and also to the President of the American Rolling Mill Company.

A motion picture, prepared by Mr. H. F. Moore at the University of Illinois, showing motion photomicrographs of Fatigue Failure of Wrought Iron was, in Mr. Moore's absence, shown by Mr. A. N. Talbot.

Owing to the lateness of the hour, it was on motion decided to defer the presentation of the remaining papers in this session until the Sixth Session on the following morning at 9.30 A. M.

The meeting then adjourned till 8 P. M.

FIFTH SESSION—WEDNESDAY, JUNE 26, 8 P. M.

Cooperation in Industrial Research.

Past-President A. A. Stevenson in the chair.

The Chair announced that at the request of the Executive Committee, Mr. Albert Ladd Colby, who represented the Society at an Anglo-American Aircraft Conference in London early in the present year, would present a brief report of his work on steel specifications at that conference.

Following the presentation of Mr. Colby's report, the Topical Discussion on Cooperation in Industrial Research was introduced by the reading by the Assistant to the Secretary of an "Opening Announcement" prepared by the Secretary-Treasurer, Mr. Edgar Marburg, and was formally opened by the presentation of the following five papers:

"General Introduction" by Mr. Henry M. Howe;
"Recent Developments in Great Britain" by Mr. John Johnston;
"Organization of Industrial Research" by Mr. Arthur D. Little;
"Developments in Industrial Research" by Mr. Charles L. Reese;
"Cooperative Research in the American Canning Industry" by Mr. Frank E. Gorrell, presented in Mr. Gorrell's absence by Mr. W. D. Bigelow.

The discussion was then continued by the presentation of the following contributions:

"Development of Existing Agencies" by Mr. Alfred D. Flinn;
"Some Practical Views of Research" by Mr. J. S. Unger;
"Cooperation of the Portland Cement Association and Lewis Institute in Experimental Studies of Concrete" by Mr. D. A. Abrams.

The meeting then adjourned till the following morning.

SIXTH SESSION—THURSDAY, JUNE 27, 9.30 A. M.

On Preservative Coatings and Non-Ferrous Metals.

Mr. W. H. Bassett in the chair.

A paper on "Cast Steel Anchor Chain" was presented by the author, Mr. H. Jasper Cox. The discussion of the paper was formally opened by Mr. W. L. Merrill and Mr. Chester K. Brooks.

A paper entitled "Grain Size of Iron as Affected by Temperature" was presented by its author, Mr. D. J. McAdam, Jr., and discussed.

A paper by Mr. J. G. Ayers, Jr., entitled "Changes within the Critical Range of a Given Steel: From Ac_1 to $Ac_{3\text{-}2}$" was, in the absence of the author, read by title.

The Chair then announced that the Executive Committee desired to present an important matter to the Society for its consideration.

The Assistant to the Secretary stated that at its meeting on Wednesday afternoon, June 26, the Executive Committee, as announced in its report, had given careful consideration to the participation of the American Society for Testing Materials as one of the founder societies in the organization of a proposed American Engineering Standards Committee as outlined in the Constitution and Rules of Procedure of such a Committee submitted by the organization committee, consisting of three representatives from each of the proposed five founder societies, namely, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society for Testing Materials. He stated that the Executive Committee had approved the scheme of organization as proposed in the Constitution and Rules of Procedure, and requested Mr. J. A. Capp, one of the representatives of the Society on the organization committee, to speak more fully on the proposed scheme of organization.

Mr. Capp then summarized briefly the method of procedure under the proposed American Engineering Standards Committee. He explained that at present there are many bodies engaged in the formulation of standards, that there is no uniform-

ity in the rules for such procedure in the different organizations, and that the present custom results in considerable duplication of work. It has accordingly seemed fitting that the five national engineering societies mentioned above, together with three Government Departments, namely, the Department of Commerce, the War Department and the Navy Department, should exercise a supervision over the way in which standardization should be accomplished by technical societies in general, through an American Engineering Standards Committee. Membership in the Committee will be vested in these founder societies and in the three Government departments, if the latter accept the invitation to participate. The proposed Constitution and Rules of Procedure provide briefly that the work of standardization shall be delegated to "Cooperating Societies"—not necessarily one of the founder societies—who shall stand as sponsor or joint sponsor for the standards whose preparation has been entrusted to them. The sponsors organize "Sectional Committees," whose personnel must conform to certain requirements in the Rules of Procedure, Sectional committees report to their sponsor society who, if they approve the standard, may then offer it to the Engineering Standards Committee. The function of this Committee is then simply to see that the necessary regulations governing the preparation of the standard have been observed, when by a certain restricted vote of the Committee it may become a "Tentative Standard" or "Recommended Practice," and later, after approval by the sponsor society, and again by a restricted vote of the Committee, it may become an "American Standard."

Mr. Capp then illustrated this method of procedure by showing how an A.S.T.M. standard would finally become an "American standard." He also pointed out that the Rules of Procedure are based largely upon the present method of conducting the committee work of this Society.

Mr. Capp then moved that the following resolution be referred to letter ballot vote of the Society:

> *Resolved*, That the American Society for Testing Materials approves the scheme of organization of the proposed American Engineering Standards Committee, as outlined in the Constitution and Rules of Procedure sub-

mitted, and agrees to participate as a founder, as recommended by the Executive Committee.

This motion was unanimously carried.[1]

(NOTE.—The Constitution and Rules of Procedure of the proposed American Engineering Standards Committee referred to in the above motion are presented in Appendix II to this Summary of the Proceedings.)

The report of Committee D-1 on Preservative Coatings for Structural Materials was presented by its chairman, Mr. P. H. Walker. On motion of Mr. Walker, the Tentative Methods for Routine Analysis of Dry Red Lead (D 49-17 T) and the Tentative Methods for Routine Analysis of Yellow, Orange, Red and Brown Pigments containing Iron and Manganese (D 50-17T) were referred to letter ballot of the Society for adoption as standard.

On motion of Mr. Walker, the proposed Tentative Specifications for Foots Permissible in Properly Clarified Pure Raw Linseed Oil from North American Seed, and the proposed Tentative Test for Flash Point of Paint Thinners other than Turpentine, were accepted for publication among the tentative standards of the Society.

Mr. Walker then presented certain minor amendments to the report of Sub-Committee XIV on the Preparation of Iron and Steel Surfaces for Painting. On motion, the report as amended was accepted for publication in the Proceedings of the Society.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was presented by its chairman, Mr. William Campbell. On motion of Mr. Campbell, the following tentative specifications, amended as indicated in the report of the committee, were referred to letter ballot of the Society for adoption as standard:

For Spelter (B 6-17 T);
For Copper Plates for Locomotive Fireboxes (B 11-16 T);
For Copper Bars for Locomotive Staybolts (B 12-16 T);
For Seamless Copper Boiler Tubes (B 13-16 T);
For Seamless Brass Boiler Tubes (B 14-16 T);
For Brass Forging Rod (B 15-17 T);

[1] The resolution referred to was adopted by letter ballot of the Society on August 26, 1918. —ED.

For Free-Cutting Brass Rod for Use in Screw Machines (B 16–17 T), in its proposed amended form as recommended by the committee.

Mr. Campbell then moved that the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent, Zinc, 2 per cent (B 10–15 T) as amended in the report of the committee, be further amended by eliminating the proposed new requirement that the yield point shall be 15,000 lb. per sq. in., and referred in its finally amended form to letter ballot of the Society for adoption as standard. This motion was unanimously carried.

On motion of Mr. Campbell, the following proposed new tentative specifications and methods were accepted for publication among the tentative standards of the Society:

For Cartridge Brass;
For Cartridge Brass Disks;
For Naval Brass Rods for Structural Purposes;
For Bronze Bearing Metals for Turntables and Movable Railroad Bridges, with certain revisions in the requirements for chemical composition and physical properties;
For White Metal Bearing Alloys (Babbitt Metals);
For Chemical Analysis of Manganese Bronze;
For Chemical Analysis of Gun Metal.

On motion of Mr. Campbell, the following three proposed tentative specifications were accepted for publication among the tentative standards of the Society, provided that a subsequent letter ballot of Committee B-2 on these specifications should be carried without a dissenting vote, these items not having previously been submitted to letter ballot of the committee, as required by the Regulations Governing Standing Committees:[1]

For Aluminum Ingots for Remelting and for Rolling;
For Aluminum Sheet;
For Light Aluminum Casting Alloys.

Mr. Campbell then called attention to the proposed revisions in the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment in Ingots, Castings and Finished Car and

[1] The subsequent vote by letter ballot of Committee B-2 was affirmative without a dissenting vote, and the three tentative specifications are therefore printed in these Proceedings, pp. 492–501.

Tender Bearings (B 17–17 T) contained in its report, and stated that at a meeting of the committee held the previous afternoon it had been decided to recommend that the maximum percentages of total impurities in the proposed new bearing metals Nos. 1 and 2 be changed from 1 and 1.5 to 1.5 and 2 per cent, respectively. Mr. Campbell moved that the specifications as thus amended be continued as tentative for another year. After considerable discussion this motion was lost.

Mr. E. J. Edwards then moved that the specifications in their present tentative form as printed in the 1917 Proceedings be continued as tentative, and that the committee be requested to give further consideration to the revisions proposed in its report.

Mr. J. A. Capp moved to amend this motion by continuing the specifications as tentative in their proposed revised form as recommended by the committee in its printed report, without the further proposed revision relating to impurities. This amendment was accepted by Mr. Edwards and the motion as amended was unanimously carried.

At the request of a number of interested persons the motion photomicrographs of Fatigue Failure of Wrought Iron, prepared by Mr. H. F. Moore, were again shown.

As a special order of business, Mr. H. E. Diller, chairman of the newly organized Committee A-7 on Malleable Castings, presented proposed Tentative Specifications for Malleable Castings on behalf of that committee. He explained that they were to supersede the present Tentative Specifications for Railroad Malleable-Iron Castings (A 75–17 T) and that they had not yet been submitted to letter ballot of the committee, having been acted upon at a meeting of the committee the previous day. On motion of Mr. Diller, the proposed specifications were accepted for publication among the tentative standards of the Society, provided that a subsequent letter ballot of Committee A-7 on these specifications should be carried without a dissenting vote.[1]

A paper entitled "The Evaluation of Zinc Dust: A Proposed Method of Analysis" was presented by its author, Mr. L. A. Wilson.

A Topical Discussion on Season and Corrosion Cracking

[1] The subsequent vote by letter ballot of Committee A-7 was affirmative without a dissenting vote, and the tentative specifications are therefore printed in these Proceedings, pp. 464–466.

of Brass was formally introduced by the presentation of the following five papers:

"Season Cracking and Splitting of Tubes and Pipes" by Mr. William Campbell;

"The Causes and Prevention of Corrosion Cracking" by Mr. W. H. Bassett;

"Season Cracking" by Mr. W. Reuben Webster, read by title in Mr. Webster's absence;

"Initial Stress and Corrosion Cracking" by Mr. P. D. Merica and Mr. W. R. Woodward, presented by Mr. Woodward;

"The Prevention of Season and Corrosion Cracking of Brass Artillery Cases by Special Heat Treatment" by Mr. W. B. Price.

A written discussion by Mr. H. S. Rawdon was, in his absence, presented by Mr. R. W. Woodward.

Written discussions by Messrs. A. D. Flinn and Ernst Jonson, and Mr. R. C. Becker, were read by title in the absence of the authors.

The discussion was then thrown open to the meeting.

The meeting then adjourned till 8 P. M.

SEVENTH SESSION—THURSDAY, JUNE, 27, 8 P. M.

Joint Session with the American Concrete Institute on Cement and Concrete.

Mr. Robert W. Lesley in the chair.

On the invitation of the Chair, Mr. E. D. Boyer, chairman of the Golf Tournament Committee, awarded the following prizes as a result of the tournament held Thursday afternoon:

For Low Score for the Course:

The American Society for Testing Materials Championship Cup and a medal: Mr. Robert E. Griffith, Philadelphia, Pa.

For the Lowest Net Score:

First Prize.........Mr. W. B. Price, Waterbury, Conn.
Second Prize.......Mr. E. E. Hughes, Franklin, Pa.
Third Prize.... ...Mr. R. S. MacPherran, Milwaukee, Wis.

The report of Committee D-2 on Lubricants was, in the absence of the chairman, Mr. C. P. Van Gundy, presented by Mr. K. G. Mackenzie, secretary. On motion of Mr. Mackenzie, the Tentative Tests for Lubricants (D 47–17 T), revised as indicated in the report of the committee, were unanimously referred to letter ballot of the Society for adoption as standard.

A paper entitled "The Standard Saybolt Universal Viscosimeter" was presented by the author, Mr. Winslow H. Herschel.

A paper on "Internal-Combustion Engine: Lubrication and Lubricants" by Mr. P. H. Conradson, was read by title in the absence of the author.

A paper entitled "The Variable-Pressure Method for the Measurement of Viscosity" was presented by the author, Mr. E. C. Bingham, and discussed.

A paper entitled "Effects of Grading of Sands and Consistency of Mix upon the Strength of Plain and Reinforced Concrete," by Mr. L. N. Edwards was, in the absence of the author, read by title.

The meeting then adjourned till 3 P. M.

NINTH SESSION—FRIDAY, JUNE 28, 3 P. M.

On Ceramics and Road Materials.

Mr. Clifford Richardson in the chair.

The report of Committee C-4 on Clay and Cement Sewer Pipe was presented by its chairman, Mr. Rudolph Hering. On motion of Mr. Hering, the proposed revisions in the Tentative Specifications for Clay Sewer Pipe (C 13–16 T) and the Tentative Specifications for Cement-Concrete Sewer Pipe (C 14–17 T), embodied in the Appendix to the report, were unanimously approved.

Mr. Hering then moved that these two tentative specifications, as revised, be continued as tentative.

Mr. Ernest Ashton moved an amendment to this motion that the requirement for maximum absorption of 5 per cent in the Specifications for Clay Sewer Pipe, and 8 per cent in the Specifications for Cement-Concrete Sewer Pipe be omitted.

This amendment was seconded by Mr. W. M. Kinney and after considerable discussion was carried. A division being called for, the vote was recorded as 29 affirmative, 7 negative.

Mr. Hering's motion, as thus amended, was then carried by unanimous vote.

On motion of Mr. Hering, the recommendation of the committee that the Tentative Specifications for Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling (C 15–17 T) and the Tentative Recommended Practice for Laying Sewer Pipe (C 12–17 T) be continued as tentative without amendment, was approved.

Mr. Hering then presented certain addenda to the report of the committee, which was on motion accepted for publication with the report in the Proceedings.

A paper entitled "The Necessity for Inspection and Testing of Refractory Brick" by Mr. C. E. Nesbitt and Mr. M. L. Bell was then presented by Mr. Nesbitt and discussed.

The report of Committee C-8 on Refractories was presented by its chairman, Mr. A. V. Bleininger. On motion of Mr. Bleininger, the Tentative Test for Refractory Materials under Load at High Temperatures (C 16–17 T) in its proposed revised form as recommended by the committee, the Tentative Methods for Ultimate Chemical Analysis of Refractory Materials (C 18–17 T) in their proposed revised form as recommended by the committee, and the Tentative Test for Slagging Action of Refractory Materials (C 17–17 T) were continued as tentative.

On motion of Mr. Bleininger the proposed Tentative Method for Determination of Porosity and Permanent Volume Changes in Refractory Materials was accepted for publication among the tentative standards of the Society.

A paper on "Silica Cement" was introduced by its author, Mr. R. J. Montgomery.

The report of Committee C-10 on Hollow Building Tile was presented by the Assistant to the Secretary in the absence of its chairman, Mr. L. H. Provine.

The report of Committee D-4 on Road Materials was presented by its secretary, Mr. Prévost Hubbard, in the absence of the chairman, Mr. L. W. Page. On motion of Mr. Hubbard,

the following Tentative Standards were referred to letter ballot of the Society for adoption as standard:

Tentative Test for Determination of Apparent Specific Gravity of Coarse Aggregates (D 30–17 T);
Tentative Form of Specifications for Certain Commercial Grades of Broken Stone (D 35–16 T);
Tentative Definitions of Terms Relating to Materials for Roads and Pavements (D 8–17 T), including clinker, mesh, slag, petroleum, topped petroleum, rock asphalt, bituminous emulsion, viscosity, penetration, aggregate, screen, sieve, and bank gravel.
Tentative Test for Toughness of Rock (D 3–17 T), in its proposed amended form as recommended by the committee.

On motion of Mr. Hubbard, the revisions recommended by the committee in the following two standards were unanimously referred to letter ballot of the Society for adoption as standard:

Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment (D 20–16);
Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregates Used in Cement Concrete (D 7–16).

Mr. Hubbard called attention to a typographical error in Appendix II to the report of the committee in giving metric equivalents of dimensions in inches in the proposed revision of Standard Method D 7–16.

On motion of Mr. Hubbard, the proposed new Tentative Tests for Determination of Apparent Specific Gravity of Sand, Stone and Slag Screenings and Other Fine Non-Bituminous Highway Materials were accepted for publication among the tentative standards of the Society; and the Tentative Method for Determination of Softening Point of Bituminous Materials other than Tar Products (D 36–16 T) was continued as tentative.

In the absence of the authors, the following two papers were presented by title:

"An Abrasion Test for Stone, Gravel and Similar Aggregates" by Mr. H. H. Scofield;
"The Sampling of Deposits of Road Stone and Gravel in the Field" by Mr. L. Reinecke and Mr. K. A. Clark.

The meeting then adjourned till 8 P. M.

TENTH SESSION—FRIDAY, JUNE 28, 8 P. M.

On Miscellaneous Subjects.

President-elect G. H. Clamer in the chair.

The report of Committee C-5 on Fireproofing was presented by its chairman, Mr. I. H. Woolson, who recommended on behalf of the committee that certain revisions be made in the proposed Standard Specifications for Fire Tests of Materials and Construction, appended to the report.[1]

On motion of Mr. Woolson, these proposed revisions were approved and the specifications, as revised, referred to letter ballot of the Society for adoption as standard, with the understanding that, if adopted, they will replace the present Tentative Method for Control of Fire Tests and Classification of Materials and Construction as Determined by Test (C 19–17 T), as well as the Standard Test for Fireproof Floor Construction (C 2–08) and Standard Test for Fireproof Partition Construction (C 3–09).

The report of Committee D-6 on Coke was introduced by its chairman, Mr. Richard Moldenke. On motion of Mr Moldenke, the proposed revisions in the Tentative Methods for Laboratory Sampling and Analysis of Coke (D 37–16 T) were approved and the Methods as thus revised referred to letter ballot of the Society for adoption as standard.

The report of Committee D-8 on Waterproofing, in the absence of the acting chairman, Mr. L. W. Walter, was presented by the Assistant to the Secretary, on whose motion the following tentative specifications were continued as tentative:

For Asphalt for Use in Damp-proofing and Waterproofing (D 40–17 T);

[1] These revisions appear in detail in an Addendum to the Report of Committee C-5, p. 283.

For Primer for Use with Asphalt for Use in Damp-proofing and Waterproofing (D 41–17 T);

For Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 42–17 T);

For Creosote Oil for Priming Coat with Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 43–17 T).

The report of Committee D-9 on Electrical Insulating Materials was presented by its chairman, Mr. C. E. Skinner. On motion of Mr. Skinner, the Tentative Tests for Molded Insulating Materials (D 48–17 T) were continued as tentative.

In the absence of the chairman, Mr. B. W. Dunn, the report of Committee D-10 on Shipping Containers was presented by the Assistant to the Secretary, on whose motion the Tentative Specifications for Canned Foods Boxes, Nailed and Lock-Corner Construction (D 44–17 T), and for Canned Foods Boxes, Wirebound Construction (D 45–17 T), were continued as tentative.

The report of Committee D-11 on Rubber Products was, in the absence of its chairman, Mr. E. A. Barrier, presented by its secretary, Mr. S. C. Potts, who reported that the committee, in pursuance of action taken at a meeting the previous evening, desired to withdraw the proposed Tentative Specifications for Braided Leader Hose for Use with Pneumatic Tools for further consideration of the committee. On motion, this action was approved.

On motion of Mr. Potts, the proposed Tentative Specifications for Rubber Belting for Power Transmission, and the proposed Tentative Specifications for Steam Hose, each slightly revised as to form, were accepted for publication among the tentative standards of the Society.

On motion of Mr. Potts, the Tentative Specifications for 2½, 3 and 3½-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use (D 26–16 T) and the Tentative Specifications for Air-Line Hose for Pneumatic Tools (D 46–17 T) were referred to letter ballot of the Society for adoption as standard.

In pursuance of action taken at a meeting of the committee, the recommendation in its report that the proposed Tentative

Specifications for Insulated Wire and Cable: 30-per-cent Hevea Rubber (D 27–16 T) be referred to letter ballot for adoption as standard was withdrawn, and on motion of Mr. Potts the specifications were continued as tentative for another year.

A brief progress report on behalf of Committee D-5 on Coal, Mr. G. S. Pope, chairman, was presented by the Assistant to the Secretary.

The Chair then declared the meeting adjourned *sine die.*

APPENDIX I.

MEMBERS PRESENT OR REPRESENTED.

(TOTAL....475)

A

Abraham, Herbert.
Abrams, D. A.
Aertsen, G.
Affleck, B. F.
Ajax Metal Co.,
  G. H. Clamer.
Allen, H. B.
Aluminum Castings Co.,
  W. A. Gibson.
American Brass Co.,
  William H. Bassett.
American Bureau of Shipping,
  Henry C. E. Meyer.
American Clay Machinery Co.,
  H. D. Van Doorn.
American Concrete Pipe Association,
  J. H. Libberton.
American Engineering Co.,
  G. E. Smith.
American Foundrymen's Association,
  A. O. Backert.
American Institute of Architects,
  Thomas Nolan.
American Locomotive Co.,
  F. J. Cole.
American Malleable Castings Co.,
  C. V. La Marche.
American Steel and Wire Co.,
  S. M. Rodgers.
American Welding Co.,
  Charles L. Rowland.
American Zinc, Lead and Smelting Co.,
  Edward Schramm.
Amies Road Co.,
  W. T. Newcomb.
Anderson, Louis, Jr.
Anderton, Benjamin A.
Ashton, Ernest.
Associated Metal Lath Manufacturers,
  Z. W. Carter.
Aston, James.
Atlantic Refining Co.,
  F. C. Robinson.
Aupperle, J. A.

B

Backert, A. O.
Baldwin Locomotive Works, The,
  J. A. Hance.
Barber Asphalt Paving Co.,
  J. S. Miller, Jr.
Barbour, Frank A.
Barrett Co., The,
  W. S. Babcock.
Barron, Edward T.
Bartlett, Geo. S.
Bartlett, Haywood and Co.,
  Henry L. Underhill.
Bates, P. H.
Beall, F. F.,
  W. C. Peterson.
Bemis Bros. Bag Co.,
  A. H. Clarke.
Berry, H. C.
Bethlehem Steel Co.,
  F. A. Weymouth.
Bigelow, W. D.
Birdsboro Steel Foundry and Machine Co.,
  Leon B. Thomas.
Blackmer, L. G.
Blair, C. C.
Blair, Will P.
Blanchard, Arthur H.
Bleininger, A. V.
Boeck, Percy A.
Boggs, C. R.
Borgner Co., Cyrus,
  Cyrus Borgner.
Bornstein, Hyman.
Boyer, E. D.
Boyle, C. L.
Bragg, C. T.
Bragg, J. G.
Braid, Arthur F.
Brighton Mills,
  W. O. Jelleme.
Brinton, F. H.
Brown, G. S.
Brunner, John.
Buck, D. M.
Buell, William H.
Bunnell, F. O.
Bureau of Steam Engineering, U.S.N. Navy Department,
  A. R. Cheyney.
Bureau of Construction and Repair, U. S. N., Navy Department,
  E. L. Lasier.
Bureau of Steam Engineering, U.S.N., Naval Experiment Station,
  D. J. McAdam, Jr.
Burgess, Geo. K.

Burrows, Charles W.
Byers Co., A. M.,
James Aston.

C

Cain, J. R.
Calumet Steel Co.,
A. S. Hook.
Cambria Steel Co.,
Geo. E. Thackray.
Camden Forge Co.,
Geo. N. Losee.
Camp, Arthur D.
Campbell, Sumner E.
Campbell, William.
Capp, J. A.
Carnegie Steel Co.,
C. F. W. Rys.
Carpenter Steel Co., The,
J. H. Parker.
Central Iron and Steel Co.,
Ashton D. Peace.
Chapin, Jos. E.
Chase Rolling Mill Co.,
Chas. H. Stokesbury.
Cheesman, Frank P.
Church, Sumner R.
Claiborne, Charles H.
Coates, John B.
Cobb, E. B.
Cohen, A. B.
Colby, Albert Ladd.
Colonial Steel Co.,
N. B. Hoffman.
Columbia Steel and Shafting Co.,
E. T. Ickes.
Comstock, Geo. F.
Concrete Products Co.,
C. F. Buente.
Conn, Charles F.
Connolly, R. D.
Cook, Oscar U.
Cooke, G. W.
Cooper, William A.
Corse, W. M.
Cowan, Wm. A.
Cowdrey, Irving H.
Cramp and Sons Ship and Engine Building Co., The William,
W. A. Dobson.
Crandell, John S.
Crawford, J. C.
Crescent Portland Cement Co.,
O. C. Hasse.
Cromwell, O. C.
Crowe, John J.
Crum, R. W.
Cummings, Robert A.
Cushman, Allerton S.

D

Dalton, G. S. J.
Damascus Bronze Co.,
William K. Frank.
Daniel, Frank W.,
Robert S. Postmontier.
Davies, Geo. C.
Davis Library of Highway Engineering,
A. H. Blanchard.
Davis, S. D.
Davis, Watson.
de Forest, Alfred V.
De Knight, Edward W.
Department of Wharves, Docks and Ferries, Philadelphia,
G. S. Webster.
Devries, Ralph P.
Dibble, R. H.
Dickey, Walter S.
Diller, H. E.
Dixon Crucible Co., Jos.,
M. McNaughton.
Dominion Steel Foundries Co., Limited,
Fred A. Loosley.
Douty, D. E.
Dow, Allan W.
Draney, J. R.
Drew, H.
Dunbar, W. O.
Duncan, Malcolm.
Dunn, F. B.
Dunn, W. R.

E

Eastick, Thomas H. A.
Ecole Polytechnique Library,
Joseph Haynes.
Edgerly, D. W.
Edwards, E. J.
Edwards, L. N.
Electric Boat Co.,
Henry B. Hanley.
Electrical Testing Laboratories,
F. M. Farmer.
Ellinwood, Geo. H.
Emley, Warren E.
Engineering News-Record,
E. J. Mehren.
Enright, Bernard.

F

Faragher, W. F.
Farran, William J.

Febrey, H. H.
Finn, Alfred N.
Firestone Tire and Rubber Co.,
J. W. Cooper.
Fisk Rubber Co.,
C. W. Sanderson.
Forbes, W. A.
Fort Pitt Malleable Iron Co.,
A. M. Fulton.
France, Geo. P.
Franke, W. J.,
Franklin Steel Co.,
Edward E. Hughes.
Frasse and Co., Peter A.,
A. E. Brown.
Freeman, J. E.
Fritch, G. M.
Froehling and Robertson,
Henry C. Froehling.
Fry, Lawford H.
Fulweiler, W. H.

G

Gates, J. S.
General Electric Co., Pittsfield Works,
S. S. Martin.
General Electric Co. (Schenectady),
J. A. Capp.
General Motors Co.,
Charles H. Jumper.
Geological Survey of New Jersey,
R. B. Gage.
Gibboney, James H.
Gibbs, A. W.
Glasgow Iron Co.,
Conley B. Shoemaker, 2d.
Goldbeck, A. T.
Goldstein, H. I.
Goodyear Tire and Rubber Co.,
W. P. Keith.
Goss, W. F. M.
Greene, H. L.
Greenman, R. S.
Griffith, John H.
Griffith, R. E.
Griffiths, Frederick J.
Gulick-Henderson Co.,
Charles S. Bilyeu.
Gypsum Industries Association,
Virgil G. Marani.

H

Hall, John H.
Hammond, George T.
Harding, W. H.
Harriman, N. F.
Hartwell, S. Warren.
Harvey, Dean.
Haswell, John C.
Hatt, W. K.
Hatton, T. Chalkley.
Haven, George B.
Hawk, Lester C.
Heckel, G. B.
Heckel, James E.
Hering, Rudolph.
Hewitt Rubber Co.,
H. F. Jefferson.
Herschel, Winslow H.
Hibbard, Walter R.
Hicks, T. A.
Hill, J. C.
Hilts, H. E.
Holst, J. L.
Holstein, L. S.
Holz, Herman A.
Hough, Norman G.
Howe, Henry M.
Howe, Raymond M.
Hubbard, Prévost.
Hudson Coal Co.,
Leon A. Smith.
Hull, D. R.
Hull, Walter A.
Humphrey, Richard L.
Hunnings, S. V.
Hydraulic Press Brick Co.,
F. H. Chapin.

I

Ickes, E. T.
Illinois Steel Co.,
P. E. Carhart.
Illinois Steel Co., Warehouse Department,
H. N. Copthorne.
Ingalls, F. P.
Inspection Department, Associated Factory Mutual Fire Insurance Co.,
E. A. Barrier.
International Silver Co.,
J. A. Hutchinson.
Interocean Oil Co.,
Leroy M. Law.
Iron Age, The,
Edwin F. Cone.

J

Jackson, Frank H.
Jackson, John L.
Jaquith, Horace J.
Jeffers, John M.
Jefferson, H. F.
Jeffries, Zay.
Jennison, H. C.
Jeter, Richard C

Job, Robert.
Jobson, T.
Johnson, A. N.
Johnson, Nathan C.
Johnson, Reeves K.
Johnston, John.
Johnston, R. L.
Jones and Laughlin Steel Co.,
Jesse J. Shuman.
Jones, Jessie L.
Jumper, Charles H.

K

Kaul, John L.
Kelley, F. W.
Kenney, E. F.
Kenney, L. H.
Kernan, F. M., Jr.
Kershaw, William H.
Kier, P. S.
Kilgus, H. E.
Kimmel, H. R.
Kingdon, Frank H.
Kinney, William M.
Kirkpatrick, F. A.
Kleeberg, Felix.
Kohr, D. A.

L

Laclede-Christy Clay Products Co.,
R. D. Hatton.
Lackawanna Steel Co.,
F. E. Abbott.
Lafayette College Library,
Eugene C. Bingham.
Lane and Co., J. H.,
C. B. Finckel.
Lanza, Gaetano.
Lasier, E. L.
Lebanon Steel Foundry,
W. H. Worrilow.
Lee Tire and Rubber Co.,
Donald F. Cranor.
Leech, J. O.
Leeds and Northrup Co., The,
M. E. Leeds.
Lehigh Valley Railroad,
Stewart E. Printz.
Lenhart, James M.
Lesh, Ira B.
Lesley, Robert W.
Lewis, H. M.
Lewis, H. R.,
G. R. Brophy.
Lewis Institute,
Stanton Walker.
Lima Locomotive Works, Incorporated, The,
W. E. Woodward.
Little, Incorporated, A. D.,
A. D. Little.
Lloyds Register of Shipping,
H. Jasper Cox.
Lober, W. D.
Lock Joint Pipe Co.,
A. M. Hirsh.
Love, H. J.
Lowe Brothers Co.,
D. A. Kohr.
Lucas and Co., John,
James E. Heckel.
Lutts, C. G.
Lynch, T. D.

M

Mace, A. W.
MacFarland, H. B.
MacGregor, John R.
Mackenzie, K. G.
MacPherran, R. S.
Marble, Edwin H.
Marquette Cement Manufacturing Co.,
T. G. Dickinson.
Marsh, C. P.
Marsh, L. S.
Mathews, John A.
Mathias, D. L.
McCombe, A. S.,
W. H. Rook.
McDonnell, M. E.
McKelvy, F. G.
McKinley, J. M.
McKinney, P. E.
McNaugher, D. W.
McNiff, G. P.
Mead, Charles A.
Merica, Paul D.
Midvale Steel Co.,
G. Aertsen.
Miller, George A., Jr.
Miller, J. S., Jr.
Millwood, James P.
Mohr, Charles T.
Moldenke, Richard.
Moller and Schumann Co.,
Everett J. Cole.
Montgomery, Robert J.
Mory, A. V. H.
Moyer, Albert.
Murphy, Louis E.

N

National Cash Register Co.,
A. B. Bearer.
National Malleable Castings Co.,
Chester K. Brooks.

National Tube Co.,
F. N. Speller.
Nelson, John H.
Nemzek, L. P.
New Jersey Zinc Co.,
W. H. Hendricks.
New York Central Railroad Co. (East of Buffalo), Engineering Department,
A. W. Carpenter.
Newcomb, Robert E.
Nichols, R. M.
Nishioka, T.
Norris, G. L.
Northern Malleable Iron Co.,
F. R. Angell.

O

Okonite Co., The,
James P. Millwood.
Olsen, Thorsten Y.
Olsen, Tinus.
Olson, L. W.
Organ, Thomas O.

P

Page, L. W.
Panama Canal, The,
W. A. E. Doying.
Patton Paint Co.,
G. D. White.
Pease, Burton H.
Pease, O. D. A.
Peerless Drawn Steel Co.,
J. Mason Ormsbee.
Pennsylvania Forge Co.,
E. T. Walton.
Pennsylvania Seaboard Steel Corporation,
H. J. Klaer.
Perrot, Emile G.
Philadelphia Chapter, American Institute of Architects,
D. Knickerbacker Boyd.
Pittsburgh Testing Laboratories,
P. J. Freeman.
Polk, Anderson.
Pollock, Clarence D.
Porter, Horace C.
Porter, J. Madison.
Portland Cement Association,
H. E. Hilts.
Potthoff, K. L.
Potts, Stephen C.
Pressell, George W.
Price, William B.
Pullar, H. B.
Purington Paving Brick Co.,
W. H. Terwilliger.

R

Ramsay, J. D.
Randall, Theodore A.
Rawdon, Henry S.
Reinhardt, G. A.
Remington Arms and Ammunition Co.,
H. M. Williams.
Rew, W. E.
Rhode Island Tool Co.,
Chester B. Sadtler.
Richardson, Clifford.
Robbins, Charles W.
Robinson, Samuel R.
Rogers, R. E.
Rome Iron Mills,
Clarence C. Osterhout.
Rys, C. F. W.

S

Sabin, A. H.
Salmen, F.
Sargent, George W.
Schaeffer, John A.
Schmid, M. H.
Schmitt, F. E.
Sharples, Philip P.
Shelley, Henry T.
Sherwin-Williams Co., The,
E. C. Holton.
Shuman, Jesse J.
Sillman, Joseph.
Singmaster, J. A.
Skinner, C. E.
Slater, W. A.
Smith, Blaine S.
Smith, F. G.
Smith, Francis P.
Smith, H. E.
Smith, Hartley Le H.
Smith, Irving B.
Souther Engineering Corporation, The Henry,
F. P. Gilligan.
Southern Paving Brick Manufacturers Association,
John W. Sibley.
Southern Pine Association,
John L. Kaul.
Spackman Engineering Co., Henry S.,
C. L. Conwell.
Sperry, Elmer A.
Stalknecht, A. C.
Stafford, Samuel G.
Stapleton, E. R.
Standard Asphalt Refining Co.,
R. F. Trumbull.

Standard Steel Works Co.,
A. A. Stevenson.
Starr, John J.,
J. J. Zimmerman.
Steel Co. of Canada, The,
J. G. Morrow.
Stevenson, A. A.
Stoughton, Bradley.
Symington Co., T. H.,
Donald S. Barrows.

T

Tagliabue, C. J.
Talbot, Arthur N.
Taylor, Arthur P.
Taylor, C. Marshall.
Taylor Instrument Co.,
E. N. Hurlburt.
Tefft, G. H.
Testing Laboratories, Columbia University,
W. J. Krefeld.
Testing Laboratory of St. Louis,
E. P. Withrow.
Thompson, Gustave W.
Tidewater Portland Cement Co.,
E. R. Stapleton.
Tiemann, Hugh P.
Titanium Alloy Manufacturing Co., The,
Geo. F. Comstock,
G. A. White.
Topping, W. S.
Touceda, Enrique.
Tretch, William J.
Trist, N. B.
Turner Co., J. Spencer,
C. S. Cook.

U

Uhler, J. L.
Upham, Charles M.
Unger, J. S.
United Gas Improvement Co.,
W. H. Fulweiler.
United States Gypsum Co.,
Virgil G. Marani.
United States Metals Refining Co. (Chrome, N. J.),
R. W. Deacon.
United States Rubber Co.,
A. A. Somerville.
United States Smelting, Refining and Mining Co., Incorporated,
F. F. Colcord.

V

Vacuum Oil Co.,
F. R. Baxter.
Van Grundy, M. C.
Van Ornum, J. L.
Vassar, H. S.
Voorhees, S. S.
Von Schrenk, Hermann.

W

Waclark Wire Co.,
R. T. Roberts.
Wagner, Samuel T.
Wait, B. H.
Walker, Percy H.
Waring, F. M.
Warner, Charles.
Warner-Quinlan Asphalt Co.,
William C. Monsell.
Warwick, C. L.
Washburn, Willis F.
Washington Steel and Ordinance Co.,
S. V. Hunnings.
Wason, Leonard C.
Watson, J. Mitchell.
Webster, Geo. S.
Wertz, F. A.
Western Electric Co.,
Charles W. Robbins.
Westinghouse Air Brake Co.,
H. C. Loudenbeck.
Westinghouse Church Kerr and Co., Co.,
Cloyd M. Chapman.
Westinghouse Electric and Manufacturing Co.,
C. E. Skinner.
Whinfrey, C. G.
White, G. A.
White, G. D.
Whittier, Elmer S.
Wig, Rudolph J.
Wight, Frank C.
Wille, H. V.,
Blain W. Reiley.
Williams, Harry M.
Williams, J. P. J.
Winchester Repeating Arms Co.,
T. C. Merriman.
Wood, Edwin T.
Wood, Harold F.
Wood, Walter.
Wood Iron and Steel Co., Alan,
W. A. Cooper.
Woodroffe, G. H.
Woodward, Raymond W.
Woolson, Ira H.
Worcester Tire Fabric Co.,
C. R. Brownwell.

Wormeley, P. L.
Worth Brothers Co.,
E. F. Kenney.
Wyman and Gordon Co., The,
George F. Fuller.

Y

York Manufacturing Co.,
Charles H. Ehrenfeld.
Young, C. D.
Young, J. B.
Young, R. B.
Youngstown Sheet and Tube Co.,
G. A. Reinhardt.

Z

Zeidler, John L.

APPENDIX II.

CONSTITUTION AND RULES OF PROCEDURE

OF THE

PROPOSED AMERICAN ENGINEERING STANDARDS COMMITTEE.

PREAMBLE.

At the present time many bodies are engaged in the formulation of standards. There is no uniformity in the rules for such procedure in the different organizations; in some cases the committees engaged in the work are not fully representative, and in a considerable proportion of cases they do not consult all the allied interests. The present custom results in a considerable duplication of work, and there are in some fields several "standards" proposed for the same thing that differ from each other only slightly and that often in unimportant details. It is very much more difficult to obtain agreement between the proposers of over-lapping standards after they have been published than it would be to get the proposers to agree before they had committed themselves publicly.

The American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, having appointed this committee to consider the advisability of cooperating in Engineering Standardization, we recommend that these societies form a permanent organization by appointing a committee, as proposed in the following constitution and rules of procedure, to carry on this important work, throughout the entire field of engineering standardization.

CONSTITUTION.

1. The name of this Committee shall be the American Engineering Standards Committee, hereinafter referred to as the Main Committee.

2. The object of this Committee is to unify and simplify

the methods of arriving at engineering standards, to secure cooperation between the different societies, and to prevent duplication of work.

3. The Main Committee shall be composed of three representatives from each of the following societies:

American Society of Civil Engineers,
American Institute of Mining Engineers,
American Society of Mechanical Engineers,
American Institute of Electrical Engineers, and
American Society for Testing Materials,

and from each of the following Government departments:

Department of Commerce,
War Department, and
Navy Department.

These representatives shall be appointed by the governing bodies of the respective societies and Government departments.

4. Initially, each society and Government department shall appoint three representatives, one to serve one year, one to serve two years and one to serve three years. Each year after the first, each society and Government department shall appoint one representative to serve for three years. Representatives may be reappointed. A vacancy shall be filled by the society or Government department to which the retiring representative belonged.

5. *Officers.*—The Main Committee shall elect annually a chairman and vice-chairman from its own membership. Officers so elected shall serve for one year, or until their successors are elected. These officers shall not serve for more than three consecutive terms. Vacancies may be filled by election at any regular or special meeting, providing notice has been given in the call for the meeting.

6. The Main Committee shall elect from its own members an Executive Committee consisting of one representative of each society and Government department and may delegate to it any of its powers, except that of approving "Recommended Practices," "Tentative Standards" or "American Standards." (See Section 13.)

7. The Executive Committee shall engage a secretary, who shall not be a member of the Committee.

8. *Meetings.*—The Main Committee shall hold at least four regular meetings each year on dates to be specified by the Committee. It may hold additional meetings at any time at the call of the Chairman on not less than ten days' notice.

9. *Quorum.*—A quorum of the Main Committee for the transaction of business shall consist of at least two-thirds of the membership of the Committee. A quorum of the Executive Committee shall be not less than an even-numbered majority.

10. *Duties.*—The chief duties of the Main Committee shall be:

(*a*) To receive and pass upon recommendations for standards approved by Sectional Committees and submitted as provided in the Rules of Procedure, but not to deal with the details of any particular standard;

(*b*) To formulate rules under which the Sectional Committees shall be constituted and organized;

(*c*) To maintain a central office in the Engineering Societies Building in New York with a paid full-time secretary, which office shall also serve as a bureau of information.

11. A Sectional Committee is a committee whose personnel or composition has been approved by the Main Committee as being sufficiently comprehensive and authoritative to prepare a particular standard, or group of standards, for submission to the Main Committee.

12. The term "Cooperating Society" as here used refers, not only to any one of the societies and Government departments represented on the Main Committee, but also to any other society, a Public Service Commission, or any other body vitally concerned with engineering standards and wishing to cooperate in the work of the American Engineering Standards Committee. It is understood, however, that as far as related to the standards proposed, all cooperating societies shall abide by the rules laid down by the Main Committee.

13. Any proposed standard submitted to, and approved by, the Main Committee shall be known either as a "Recommended Practice" or as a "Tentative Standard," and when, in the opinion of this committee, after approval by the sponsor society

or societies, it has proved its suitability, it shall be known as an "American Standard."

14. (*a*) The approval as "Recommended Practice" or as "Tentative Standards" of any standard submitted to the Main Committee shall require the affirmative vote of three-fourths of the committee; the advance of status to "American Standard" shall require an affirmative vote of 90 per cent of the Main Committee. Such votes shall be by letter ballot. Letter ballots may be ordered at any regular or special meeting of the Main Committee.

(*b*) A "Recommended Practice" or "Tentative Standard" may be revised at intervals of not less than one year, by the same procedure as that required for its original approval. A period of not less than one year shall intervene between the last revision and the admission to "American Standard."

(*c*) An "American Standard" may be revised at intervals of not less than three years by the same procedure as required for its original approval.

15. *Expenses.*—As soon as possible after its organization the Main Committee shall make an estimate of its expenses for the first year and submit it to the governing bodies of the societies and Government departments represented on the Main Committee for their approval; such approval includes the pledge of each society and Government department for such share as may be agreed upon. After the first year the Main Committee shall present an annual budget to the governing bodies of the societies represented, not later than the first of December, each year.

Funds of the committee shall be in the custody of the secretary, who shall be placed under suitable bond, and shall be disbursed by him on vouchers signed by the chairman or vice-chairman.

16. Amendments to this Constitution must be proposed in writing at least thirty days before the meeting of the Main Committee at which they are to be voted on. If passed by a three-fourths majority of those present, they shall be referred to the Governing Boards of all the societies and Government departments represented in the Main Committee, and shall become operative only when all those Boards have given their approval.

RULES OF PROCEDURE.

1. Each Cooperating Society shall notify the Main Committee of the names and affiliations of the members of, and the field covered by, any existing or proposed committee dealing with a standard of any kind. It shall also send to the Main Committee not less than twenty copies of each standard which it has in force.

This information shall be assembled, classified and kept up to date by the Secretary of the Main Committee, and shall be accessible at any time to each of the Cooperating Societies.

2. (*a*) Any proposal for the development or adoption of a particular standard or group of standards shall be referred to the Main Committee, which shall request one or more of the Cooperating Societies to organize a Sectional Committee to carry on the work. The Society or Societies so designated shall be sponsor (or joint sponsor) for the work in hand, and the final recommendations of the Sectional Committee shall be made to the sponsor who shall submit these recommendations to the Main Committee. The Main Committee shall not approve these recommendations without the previous approval of the sponsor.

(*b*) Standards adopted or in process prior to (blank date)........... may be approved by the Main Committee irrespective of this Constitution and Rules of Procedure.

3. *Composition of Committees.*

(*a*) Sectional Committees dealing with standards of a commercial character (specifications, shop practices, etc.) shall be made up of representatives of producers, consumers and general interests, no one of these interests to form a majority. A producer is a person, or the representative of a firm or corporation, directly concerned in the production of the commodity involved. A consumer is a person, or the representative of a firm or corporation, that uses the commodity involved, but is not directly concerned with its production. General interests include independent engineers, educators, and persons who are neither consumers nor producers, as defined above.

(*b*) Sectional Committees dealing with standards of a scientific or non-commercial character shall consist of persons specially qualified, without regard to their affiliations.

4. Every report of a Sectional Committee shall include a list of its members, with a statement of their business, professional, and technical society affiliations. The final vote shall be stated in detail, and attested by the signature, personal or authorized, of each member voting.

5. Cooperating Societies shall not, in their publications, use the term "American Standard" except in connection with standards that have received the approval of the Main Committee.

6. "Recommended Practices," "Tentative Standards" and "American Standards" approved by the Main Committee may be printed in the publications of any Cooperating Society under the appropriate title and over the statement "Approved by the American Engineering Standards Committee." They shall not be released prior to such publication, whereupon right to publish may be granted to any other publisher upon these same conditions.

7. Amendments to the Rules of Procedure may be proposed at any meeting of the Main Committee, and, if so ordered, shall be sent in full to all members with the notice of a subsequent meeting at which they may be voted on. A three-fourths affirmative vote of those present will be required to pass an amendment.

8. Any action opposed by all of the representatives of any one society or Government department present and voting, shall be referred to the following meeting, to which this restriction shall not apply.

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROCEEDINGS.

The Society is not responsible, as a body, for the statements and opinions advanced in this publication.

ENGINEERING SOCIETIES: THEIR UTILITIES AND JUSTIFICATION.

ANNUAL ADDRESS BY THE PRESIDENT, GEN. WM. H. BIXBY.

June 25, 1917.

Ordinarily an address at an Annual Meeting of this Society would be devoted to matters concerning the history and growth of the Society; but these matters have been so thoroughly discussed by my predecessors, that it is useless for me to attempt to improve upon what has already been told the members, in past years.

I regret exceedingly that, due to the many unexpected requirements connected with the present war in Europe, I am unable to address the members myself in person; but circumstances seem to make my presence at Atlantic City impossible this year. The Society, however, has my best wishes for a successful annual meeting.

As an address on the subject of the Society itself is not in order, for the reasons given above, I shall take advantage of this opportunity to make a few remarks on the subject of Engineering Societies in general.

When I was quite small, a remark quite common was, "Of making books, there is no end." Since that date books have been

produced in such astonishing quantities that little attention is paid to such production. To-day, it might be similarly said, "Of making societies, there is no end." At the recent Pacific Exposition, it was found that there were many hundreds of engineering societies already in existence in the United States alone, counting all engineering associations of all sorts and kinds represented at or recognized by the officials of that exposition.

It must be remembered that civil engineering as a profession is of comparatively recent date. Engineering corps and societies have existed as a branch of the military profession for 500 or 600 years; but as a profession by civilians it is hardly a hundred years old. The first large society of civil engineers in England —the Institution of Civil Engineers—dates back only to about 1828; and the name of "Civil Engineers" was made use of to distinguish its members from the Royal Engineers of the army, which at that time had an engineering society of its own whose membership was restricted to military men. For many years thereafter, there were no technical engineering schools in Europe outside of the military schools. In the United States the West Point Military Academy was established as an engineering academy, to teach all branches of engineering construction, civil and military, over a hundred years ago, and for nearly thirty years it was the only engineering school in the United States. In this connection it should be borne in mind that one hundred years ago, steamboats were in their infancy, railroads were unknown, and electricity as a form of power, light, and heat, and communication, had hardly been dreamt of. Civil Engineering was therfore mainly limited to the construction of highways, canals, harbors, buildings, and a limited amount of machinery. Any one desiring to learn engineering as a profession, was obliged to become an apprentice under some local engineer, and his studies were mainly limited to such practice as his employer was occupied upon at that time. Technical schools were very few in number, less than a dozen, up to about 1860. To-day, every self-respecting State of the Union has at least one technical school, academy, college or university. About 1870, there were probably not more than twenty or thirty technical societies of any prominence. To-day, there are several times that number of societies which might properly be termed "National

Societies"; and fully that number of International technical societies; and even at least one associat'on of secretaries of international technical societies. It would seem as if we had almost reached the time when we could begin to consider a reduction in the number of new societies of engineering, rather than a further increase.

It is somewhat to be regretted that more uniformity has not been followed in the titles given to technical societies. The various organizations have received, according to circumstances, names varying from club, society, association, institute, institution, foundation, and academy. In many cases, the title has been fairly indicative of the object of the organization; but at other times, the title is somewhat confusing. The variety in names is probably largely due to the fact that not only is engineering, as above stated, a new profession, but the United States is a comparatively new country; and both profession and country are still rapidly growing. It will probably be many years yet before engineering will be fully organized as a profession and before the rank and titles of its associations will be agreed upon.

When engineering societies were first organized, their objects were somewhat different from those of to-day. In the early days of the society, an important object of its organization was to establish a list of men of engineering experience, as well as to give such individuals an opportunity of becoming acquainted with each other, and of exchanging information regarding the works undertaken or completed by each individual. It was generally expected that when the general public had any large engineering work to accomplish, it would look for engineers amongst the membership of these societies. Such objects are still important to the engineering societies to-day, but such importance is becoming less. At an early date, each of the more important societies were obliged to publicly disclaim any responsibility for the correctness of statement made by their members in public addresses or descriptions of engineering work.

As a news disseminator the engineering society has been largely replaced by the daily papers and the weekly, monthly and quarterly scientific journals. As an employment bureau, the societies have gradually become loth to discriminate between their own members, except when the call comes from the National

government. As a test of an individual's ability, membership in a society loses value in proportion as the number of members increases; so that it is still just as necessary, as in other matters, to solicit information as to engineering ability from the persons under whom the individual engineers have rendered service, instead of from their engineering societies.

The engineering society is, however, more and more valuable each day in regard to the opportunity it offers to members to become acquainted with each other individually at annual and other meetings of the society; and it is becoming still more valuable each day because of the discussion which takes place between members at such meetings; and because of the opportunities which it offers through its various committees and sub-committees, to arrive at the best method of overcoming engineering difficulties, improving processes, standardizing materials and finished constructions, and increasing quantities while at the same time improving qualities of the finished constructions; or as has sometimes been said, of procuring the most useful results per dollar of expenditure. The discussions of engineering questions, and their conversion into formulas, specifications, or other standards, through the work of committees, are becoming to-day more and more the most important features of engineering societies. In short, the engineering society of to-day which is the most important and most useful and most valuable to everybody concerned, is the one which gives the most beneficial results to the general public, rather than to the individual member. If the work of any particular society is beneficial to the entire engineering profession, and the general public, it will have earned its right to the title "Society," or "Institute;" if it is looking only after benefit to its individual members, the title of "Club" is more expressive and honest. Not until its work is beneficial to the entire engineering fraternity of the United States as a whole, has it any right to call itself a "National" society or association. As a general rule, the best work of any individual country can be done by one of its national associations; and an international organization becomes necessary and specially useful only so far as needed to reconcile serious differences between the standards of the various nations concerned.

As stated above, one of the most important functions of a

society of to-day, if not the most important, is the work of its committees to influence uniformity of ideas and standardization of methods and constructions. It is because of the predominance of this committee idea in its work that the American Society for Testing Materials has been so successful as a technical society, and is being so recognized by the general public and the Federal government. We have already 39 main committees and over 130 sub-committees, all busied with important studies and decisions. Few other engineering societies in the country, if any, show as many committees and as good work therefrom. I consider a large part of the success of our committee work is due to the unflagging industry, unusual enthusiasm, and good judgment of our Secretary, whose absence at this meeting we greatly regret and for whose speedy recovery we extend our best wishes.[1] Many committees in other societies have failed to secure the best results because they have failed to realize the importance of the essential rule laid down by our Society, that both sides of every subject treated must be fully and faithfully represented in the committee room, and that the matter at issue must be threshed out by the committee until both sides are willing to admit that the final recommendation is the one most advantageous to the interests of the two sides taken together.

Another important feature of committee organization in which our Society has been quite successful so far, is an insistence upon a committee membership of live and energetic workers. While it is important that each committee man shall be thoroughly posted upon, and a representative expert in, the line of the matter at issue, he can not do good work unless he is enthusiastic and willing to give time and thought to his committee work, and is ready to believe that his opponents are just as honest and fair to themselves as he is to himself. No committee can be expected to give the best possible results unless each member is honest, fair and enthusiastic; nor unless its membership be equally balanced between the interests at stake. As stated above, I believe our Society, because of loyal compliance with such rules, shows unusual and remarkable excellence in its

[1] The much regretted death of this Secretary, Mr. Edgar Marburg, of Philadelphia, Pa., on June 27, 1918, is a loss felt deeply not only by our own Society but by every other Society with which we have had dealings. For honesty of purpose, broad-mindedness, and devotion to the best interests of the Society and the general public, he had no superior.

committee work; and the acceptance of many of our standards by the Federal government indicates that we have the confidence of the general public and of the Federal Congress so far as we are known.

I have several times been asked what need there is at the present day of any new technical societies; and I have even been asked the very pertinent question of why our Society should not give up its independent existence and become a section of one of the other four or five principal engineering societies of the United States. My answer was several-fold. Whenever there is important work to be done which no existing society or combination of societies is willing to undertake, then a new society must be started unless we are willing to stand still or go backward. When the American Society for Testing Materials was started, no other society realized the importance of the work sufficiently to be willing to take it up fully and enthusiastically. We broke away from international societies for testing materials for somewhat the same reason; namely, that our national interests demanded more time and attention than the international society was willing to devote to one country, that is to one of its members. Another reason was that our interests were so varied that they could not be included within the interests of any other single engineering society, and to acquire full membership in those societies we would have to divide ourselves up between them all. The usefulness of our Society, independent of the other large existing engineering societies, is somewhat analogous to the usefulness of circumferentially located streets in a large city whose principal avenues radiate from a common center; and it is also somewhat analogous to the usefulness of a single library covering certain features of all branches of applied science rather than many libraries each covering only one single branch of science. In this case it is the old story that in union there is strength; and under present organizations we can do better as a Society by ourselves than we can as branches of five different societies whose directing bodies have different views and different interests. Perhaps, when the four or five large engineering organizations have reached a stage of development in which they will be willing to be sub-sections of the Engineering Foundation and have arranged to work in

thorough harmony with each other, we also may be willing to become a sub-section and may be able to do good work as such; but that date is still several years ahead of us. But before that date arrives, each of these four or five engineering organizations will have to take steps to see that it is represented by a working, live, energetic, unbiased committee, sufficiently alive and able to readily voice the views of the best element of its society, and, at the same time, to easily recognize the just views of the other societies, and which shall have received from its own society the right and power to act therefor. For the present, at least, we can be of greater value with our present organization than with any other; and such condition will remain so as long as we continue to work, not so much for each individual member, as for the general public and the entire engineering profession.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE.

Publications.—A comparative statement as to the volume of regular publications issued by the Society during the past three years is exhibited in the following:

	1915–16 Pages.	1916–17 Pages.	1917–18 Pages.
Proceedings	962	1114	1550
Book of A.S.T.M. Standards	757	752	....
Membership Pamphlet	247	229	251
Pamphlet of 4 new A.S.T.M. Standards adopted in 1917	...	...	41
Total	1966	2095	1842

The term "regular publications," as used here, applies to those publications of which every member of the Society receives a copy by virtue of his membership, without added charge. During the past year the Society has also published a book of A.S.T.M. Tentative Standards containing 359 pages, of which 261 copies have been disposed of by sale. This book was issued by direction of the Executive Committee after it had given due consideration to the following action taken by the Society at the first session of the last annual meeting:

> "That the Tentative Standards be published in the Proceedings as heretofore, and that the Executive Committee be requested to take such action as they may see fit with regard to the separate publication of the Tentative Standards."

Ten circulars to members aggregating 41 pages have also been issued during the past year.

Proposed Change from Biennial to Triennial Publication of the Book of A.S.T.M. Standards.—During the past year the Executive Committee has given much consideration to an increasing demand that the period between the publication of successive issues of the book of A.S.T.M. Standards be

lengthened from two to three years. The matter was first referred by the Executive Committee for consideration and advice to Committee E-5 on Standing Committees. That committee unanimously recommended that "beginning with the 1918 edition, the book of A.S.T.M. Standards be thereafter published triennially with the understanding (*a*) that this proposed change be brought to the notice of the Society as provided in the by-laws, in so far as the amendment of the latter may be involved, and (*b*) that suitable changes be made in the Regulations Governing Standing Committees." The Executive Committee recommends that authorization for this change in the period of publication of the book of A.S.T.M. Standards be given by the Society by referring the appropriate amendment of the by-laws thereby entailed to letter ballot of the Society.

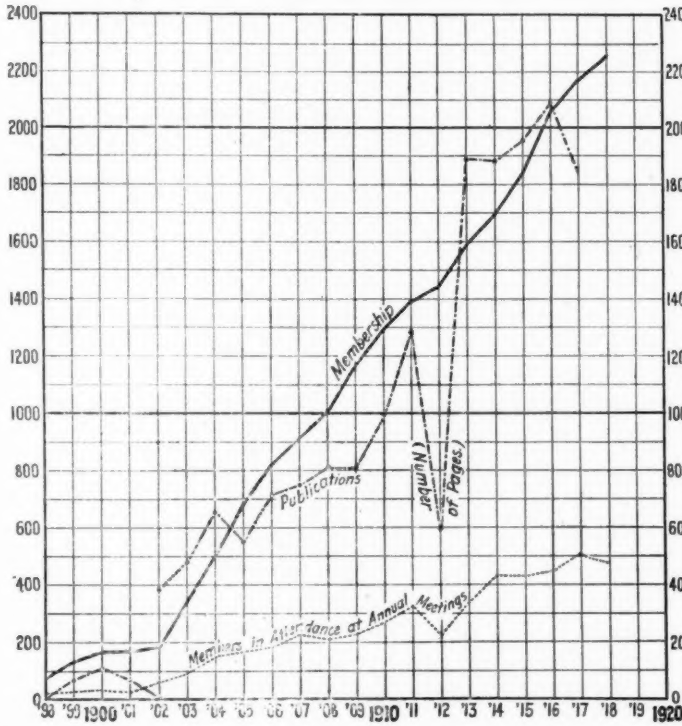
Membership.—The membership at the last annual meeting was 2167. Since then 269 applications for membership have been approved as compared with 265 during the previous year. The losses by death number 10, namely:

H. C. Adams	August 18, 1917
John G. Brown	October 22, 1917
F. Firmstone	June 27, 1917
J. L. Gaynor	October 14, 1917
E. M. Hagar	January 17, 1918
O. Z. Howard	December 20, 1917
G. M. MacNider	February 27, 1918
L. R. Pomeroy	May 7, 1917
Henry Souther	August 15, 1917
E. A. Stevens	March 8, 1918

The number of resignations is 102 and 63 members have been dropped for non-payment of dues, the former being 11 more and the latter 6 less than for the previous year. The total losses for the year from all causes number 175, and the net increase in membership for the year is 94, as compared with 96 for the previous year, and with an average net annual increase of 142 for the preceding five years.

The total membership of the Society is now 2261, of whom 224 are Junior Members.

Standing Committees.—The productive efforts of some of the standing committees have been seriously impaired through the increased pressure on the time and energies of many of their leading members through the requirements of the war. Efforts have been made to offset this by bringing the standing committees to a recognition of the fact that the work



NOTE.—The initial curve for publications (1898–1902) refers to the publications of the American Section of the International Association for Testing Materials. The marked drop for 1912 in the "publications" and "members in attendance at annual meetings" curves is due to the fact that the Sixth Congress of the International Association was held in New York in September, 1912, and that the activities of the American Society for that year were accordingly restricted to committee reports and administrative business. The drop of the "publications" curve in 1917 is explained by the fact that the book of A.S.T.M. Standards was not published that year, it being published biennially in the even years.

of the Society is of such great importance to manufacturing interests and to industrial affairs in general, on which in turn the success, or at least the duration of the war is so largely dependent, that it behooves the Society to make extraordinary efforts to prevent any impairment of its usefulness to the nation in the fields in which it has come to occupy so commanding a position. In so far, therefore, as compatible with more direct and compelling demands in relation to the war, the members of the Society—and especially those connected with the standing committees—may well regard it as a patriotic duty to intensify rather than relax their efforts in relation to the Society towards the achievement of the most fruitful results despite increasing difficulties. The indications are that some of the standing committees will find it advantageous in the early fall to give careful consideration to the desirability of more or less drastic reorganization of their personnel, with a view of stimulating energetic performance in quarters where the best results may not in the past have been forthcoming; to adopt more stringent regulations regarding attendance at meetings, etc. There can be no doubt that it would be highly creditable to the Society if every important committee should follow this alternative rather than to allow itself to atrophy by degrees through gradually increasing inactivity at the expense of the interests especially committed to their care.

The following changes during the year affecting standing committees are here recorded:

By mutual agreement and action by this Society and the American Society of Mechanical Engineers, Committee E-3 on Revision of Pipe Threads, consisting of sub-committees of (1) American Society of Mechanical Engineers, (2) Master Car Builders' Association, (3) Railway Signal Association, (4) American Gas Institute, (5) Manufacturers' Association on Standardization of Fittings and (6) American Society for Testing Materials, which has operated since 1915 under the auspices of this Society, will hereafter be conducted under the auspices of the American Society of Mechanical Engineers and will consist initially of the same elements as at present.

The designation of Committee A-6 has been changed from "Committee A-6 on Magnetic Properties of Iron and Steel," to "Committee A-6 on Magnetic Properties."

The designation of Committee D-9 has been changed from "Committee D-9 on Electrical Insulation" to "Committee D-9 on Electrical Insulating Materials."

A joint conference committee consisting of three members from each of Committees C-3 on Brick and D-4 on Road Materials, has been appointed to consider the investigation and revision of the present Rattler test and other standard tests for paving brick.

A new committee to be known as "Committee A-7 on Malleable Castings" has been created by authorization of the Executive Committee, and the present sub-committee on Malleable Castings of Committee A-3 on Cast Iron has been discontinued.

The reorganization of Committee C-7 on Lime and of Committee C-10 on Hollow Building Tile is now under consideration by the Executive Committee.

Recommendations of Standing Committees Affecting Standards.—The Regulations Governing Standing Committees provide that any recommendations affecting standards must be sent in printed form to every member of the Society not less than four weeks before the annual meeting at which these recommendations are to be presented. This regulation has been observed in connection with all of the matter listed below.

I. PROPOSED REVISIONS IN STANDARDS RECOMMENDED FOR ADOPTION.

Recommended by Committee A-1 on Steel:

- For Structural Steel for Cars (A 11–16);
- For Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17–13);
- For Carbon-Steel and Alloy-Steel Forgings (A 18–16);
- For Quenched-and-Tempered Carbon-Steel Axles, etc. (A 19–16);
- For Carbon-Steel Car and Tender Axles (A 21–14);
- For Steel Tires (A 26–16);
- For Steel Boiler Tubes, etc., for Locomotives (A 28–16);
- For Automobile Carbon and Alloy Steels (A 29–16);
- For Boiler and Firebox Steel for Locomotives (A 30–16);
- For Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15);

For Welded Steel and Wrought-Iron Pipe (A 53–15);
For Quenched-and-Tempered Alloy-Steel Axles, etc. (A 63–16).

Recommended by Committee A-2 on Wrought Iron:
For Lap-Welded Charcoal-Iron Boiler Tubes, etc., for Locomotives (A 38–16);
For Engine-Bolt Iron (A 40–13);
For Refined Wrought-Iron Bars (A 41–13);
For Wrought-Iron Plates (A 42–13);
For Iron and Steel Chain (A 56–15).

Recommended by Committee A-3 on Cast Iron:
For Gray-Iron Castings (A 48–05).

Recommended by Committee A-6 on Magnetic Properties:
Tests for Magnetic Properties of Iron and Steel (A 34–14).

Recommended by Committee D-4 on Road Materials:
Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregates Used in Cement Concrete (D 7–16);
Method for Distillation of Bituminous Materials Suitable for Road Treatment (D 20–16).

Recommended by Committee E-1 on Methods of Testing:
Methods for Testing (E 1–16).

II. TENTATIVE STANDARDS RECOMMENDED FOR ADOPTION.

Recommended by Committee A-1 on Steel:
For Steel Track Spikes (A 65–16 T);
For Steel Screw Spikes (A 66–16 T);
For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T);
For Elliptical Steel Springs for Automobiles (A 69–16 T).

Recommended by Committee A-2 on Wrought Iron:
For Staybolt Iron (A 39–17 T), as revised;[1]
For Wrought-Iron Pipe (A 72–17 T), as revised;
For Wrought-Iron Rolled or Forged Blooms and Forgings for Locomotives and Cars (A 73–17 T).

[1] Designed to replace, if adopted, the present Standard Specifications for Staybolt Iron (A 39–14).

Recommended by Committee A-3 on Cast Iron:

For Cast-Iron Soil Pipe and Fittings (A 74–17 T);

For Railroad Malleable-Iron Castings (A 75–17 T).

Recommended by Committee B-2 on Non-Ferrous Metals and Alloys:

For Spelter (B 6–17 T);[1]

For the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent (B 10–15 T) as revised:

For Copper Plates for Locomotive Fireboxes (B 11–16 T);

For Copper Bars for Locomotive Staybolts (B 12–16 T);

For Seamless Copper Boiler Tubes (B 13–16 T);

For Seamless Brass Boiler Tubes (B 14–16 T);

For Brass Forging Rod (B 15–17 T);

For Free Cutting Brass Rod for Use in Screw Machines (B 16–17 T).

Recommended by Committee C-5 on Fireproofing:

For Fire Tests of Materials and Construction (C 19).[2]

Recommended by Committee D-1 on Preservative Coatings:

Methods for Routine Analysis of Dry Red Lead (D 49–17 T);

Methods for Routine Analysis of Yellow, Orange, Red and Brown Pigments containing Iron and Manganese (D 50–17 T).

Recommended by Committee D-2 on Lubricants:

Tests for Lubricants (D 47–17 T), as revised.

Recommended by Committee D-4 on Road Materials:

Test for Toughness of Rock (D 3–17 T), as revised;[3]

Test for Determination of Apparent Specific Gravity of Coarse Aggregates (D 30–17 T);

Form of Specifications for Certain Commercial Grades of Broken Stone (D 35–16 T);

Definitions of Terms Relating to Materials for Roads and Pavements (D 8–17 T).[4]

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[1] Designed to replace, if adopted, the present Standard Specifications for Spelter (B 6–14).

[2] These specifications embody the Tentative Method for Control of Fire Tests and Classification of Materials and Construction as Determined by Test (C 19–17 T) submitted last year and if adopted, will replace that Tentative Method, as well as the existing Standard Tests for Fireproof Floor Construction (C 2–08) and for Fireproof Partition Construction (C 3–09).

[3] Designed to replace, if adopted, the present Standard Test for Toughness of Macadam Rock (D 3–08).

[4] To be included, if adopted, in the Standard Definitions of Terms Relating to Materials for Roads and Pavements (D 8–15).

Recommended by Committee D-6 on Coke:

Methods for Laboratory Sampling and Analysis of Coke (D 37–16 T), as revised.

Recommended by Committee D-7 on Timber:

Methods for Analysis of Creosote Oil (D 38–17 T).[1]

Recommended by Committee D-11 on Rubber Products:

For $2\frac{1}{2}$, 3 and $3\frac{1}{2}$-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use (D 26–16 T);

For Insulated Wire and Cable: 30-per-cent Hevea Rubber (D 27–16 T);

For Air-Line Hose for Pneumatic Tools (D 46–17 T).

III. PROPOSED NEW TENTATIVE STANDARDS.

Recommended by Committee B-2 on Non-Ferrous Metals and Alloys:

For Cartridge Brass;

For Cartridge Brass Disks;

For Naval Brass Rods for Structural Purposes;

For Bronze Bearing Metals for Turntables and Movable Railroad Bridges;

For White Metal Bearing Alloys (Babbitt Metals);

Methods for Chemical Analysis of Manganese Bronze;

Methods for Chemical Analysis of Gun Metal.

Recommended by Committee C-8 on Refractories:

Method for Determination of Porosity and Permanent Volume Changes in Refractory Materials.

Recommended by Committee D-1 on Preservative Coatings:

For Foots Permissible in Properly Clarified Pure Raw Linseed Oil from North American Seed;

Test for Flash Point of Paint Thinners other than Turpentine.[2]

Recommended by Committee D-4 on Road Materials:

Tests for Determination of Apparent Specific Gravity of Sand, Stone and Slag Screenings and Other Fine Non-Bituminous Highway Materials.

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[1] To be included, if adopted, in the Standard Methods for Sampling and Analysis of Creosote Oil (D 38–17).

[2] To be included, when adopted, in the Standard Tests for Paint Thinners other than Turpentine (D 28–17).

Recommended by Committee D-7 on Timber:

For Wooden Paving Blocks.

Recommended by Committee D-11 on Rubber Products:

For Braided Leader Hose for Use with Pneumatic Tools;
For Rubber Belting for Power Transmission;
For Steam Hose.

IV. Proposed Revisions in Tentative Standards, to be Continued as Tentative.

Recommended by Committee A-1 on Steel:

For Steel Tie Plates (A 67–17 T).

Recommended by Committee B-2 on Non-Ferrous Metals and Alloys:

For Non-Ferrous Alloys for Railway Equipment (B 17–17 T).

Recommended by Committee C-4 on Clay and Cement Sewer Pipe:

For Clay Sewer Pipe (C 13–17 T);
For Cement-Concrete Sewer Pipe (C 14–17 T).

Recommended by Committee C-8 on Refractories:

Test for Refractory Materials under Load at High Temperatures (C 16–17 T);
Methods for Ultimate Chemical Analysis of Refractory Materials (C 18–17 T).

Recommended by Committee D-13 on Textile Materials:

General Methods for Testing Cotton Fabrics (D 39–16 T).[1]

Recommended by Committee E-4 on Magnification Scales for Micrographs:

Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2–17 T).

V. Tentative Standards to be Continued without Revision.

Recommended by Committee A-1 on Steel:

For Boiler and Firebox Steel for Stationary Service (A 70–17 T);
For Carbon Tool Steel (A 71–17 T).

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[1] This method as revised is designed to replace the existing one of the same title and the following Tentative Tests: For Automobile Tire Fabrics (D 31–16 T); for Cotton Fabric for Use in Hose, Belting and Similar Articles (D 32–16 T); and for Cotton Fabrics for Use in Bags and Bagging Material (D 33–16 T).

Recommended by Committee B-2 on Non-Ferrous Metals and Alloys:
Methods for Analysis of Alloys of Lead, Tin, Antimony and Copper (B 18–17 T).

Recommended by Committee C-1 on Cement:
Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9–16 T).

Recommended by Committee C-4 on Clay and Cement Sewer Pipe:
For Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling (C 15–17 T);
Recommended Practice for Laying Sewer Pipe (C 12–17 T).

Recommended by Committee C-8 on Refractories:
Test for Slagging Action of Refractory Materials (C 17–17 T).

Recommended by Committee D-4 on Road Materials:
Method for Determination of Softening Point of Bituminous Materials other than Tar Products (D 36–16 T).

Recommended by Committee D-7 on Timber:
For Selected Structural Douglas Fir Bridge and Trestle Timbers (D 23–16 T);
For Southern Yellow-Pine Timber to be Creosoted (D 24–15 T);
For Southern Yellow-Pine Piles and Poles to be Creosoted (D 25–15 T).

Recommended by Committee D-8 on Waterproofing:
For Asphalt for Use in Damp-proofing and Waterproofing (D 40–17 T);
For Primer for Use with Asphalt for Use in Damp-proofing and Waterproofing (D 41–17 T);
For Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 42–17 T);
For Creosote Oil for Priming Coat with Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 43–17 T).

Recommended by Committee D-9 on Electrical Insulating Materials:
Tests for Molded Insulating Materials (D 48–17 T).

Recommended by Committee D-10 on Shipping Containers:
For Canned Foods Boxes, Nailed and Lock-Corner Construction (D 44–17 T);
For Canned Foods Boxes, Wirebound Construction (D 45–17 T).

The committees responsible for the following Tentative Standards do not expect to present reports this year, and the Tentative Standards will accordingly be continued without revision:

Tentative Specifications for Mason's Hydrated Lime (C 6–17 T);

Tentative Definitions of Terms Relating to the Gypsum Industry (C 11–16 T).

Finances.—The wisdom of the measures taken within recent years towards strengthening the financial condition of the Society, especially the action by which the annual dues were increased from $10 to $15 per annum at the beginning of the fiscal year 1916, is abundantly attested by the tabulated data bearing on the financial condition of the Society at the close of the fiscal years 1913–1917 inclusive, from which it will be seen that the deficit at the end of the fiscal year, which had gradually grown to $6407.03 by the end of 1915, has been converted to a surplus of $3140.09 by the end of 1916, and to one of $11,955.53 by the end of 1917. This statement as to surplus does not include an appraised value of office furniture and fixtures nor of the large stock of back publications whose inventory, as given later in the report, may conservatively be estimated at $11,756.75.

REPORT OF AUDITORS FOR THE FISCAL YEAR JANUARY 1, 1917, TO DECEMBER 31, 1917.

JOHN HEINS AND CO.
PUBLIC ACCOUNTANTS AND AUDITORS.

PHILADELPHIA, January 2, 1918.

Mr. Edgar Marburg, *Secretary-Treasurer,*
American Society for Testing Materials,
Philadelphia, Pa.

Dear Sir:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1917; having previously made a similar audit and report for the preceding six months ended June 30, 1917, and at both audits found the accounts to be correct, and to be in their usual excellent condition.

We submit balance sheet as of December 31, 1917, as also a statement of operations for the twelve months then ended, schedules of accounts receivable, etc.

Respectfully submitted,
(Signed) JOHN HEINS AND CO.

BALANCE SHEET DECEMBER 31, 1917.

ASSETS.

Cash		$9 584.82	
Accounts Receivable:			
Other than Members	$1 114.56		
Members for Publications	100.60		
Members for 1917 Dues	1 386.55		
		2 601.71	
			$12 186.53

LIABILITIES.

Accounts Payable		none	
Members dues paid in advance		$231.00	
Life Membership	$1 300.00		
Surplus	10 655.53		
		11 955.53	
			$12 186.53

NOTE.—The stock of back publications and the office furniture are not appraised or included in this statement.

MISCELLANEOUS FUNDS.

In addition to the above cash the Secretary-Treasurer has on hand the following Funds:

Committee A-5 on Corrosion of Iron and Steel	$123.52	
Committee C-1 on Cement	4 856.33	
Committee C-9 on Concrete and Concrete Aggregates	597.19	
Committee C-10 on Hollow Building Tile	184.39	
		5 761.43
Total		$5 761.43

RECEIPTS AND DISBURSEMENTS.
JANUARY 1 TO DECEMBER 31, 1917.

Cash on hand January 1, 1917			$845.78
RECEIPTS.			
Current dues	$30 266.96		
Past dues	584.50		
Advance dues	231.00		
		$31 082.46	
Binding (Members)		294.00	
Sale of Publications:			
Separate standards	$771.87		
Book of Standards, Proceedings, etc.	4 801.54		
		5 573.41	
Sale of right to reprint standards		1 200.00	
Authors' reprints		120.26	
Sale of Certificates of Membership		32.50	
Interest on deposits		388.62	
Miscellaneous		152.54	
Total receipts			38 843.79
			$39 689.57
DISBURSEMENTS.			
Publications		$17 212.58	
Salaries: Secretary-Treasurer	$3 600.00		
Assistant to the Secretary	1 500.00		
Regular clerical	3 469.95		
Extra clerical	701.34		
		9 271.29	
Expenses, Standing Committees		1 157.32	
Expenses, Nominating Committee		92.53	
Expenses, Secretary-Treasurer's office		587.96	
Postage and expressage, Secretary-Treasurer's office		533.58	
Typewriter and desk		106.50	
Rent and Insurance, Storage room		201.60	
Auditing accounts		86.00	
Engrossing certificates of membership		16.75	
Stenographer, annual meeting		200.00	
Net expenses, annual meeting		488.14	
Refund of excess remittances		60.15	
Miscellaneous		90.35	
Total disbursements			30 104.75
Cash on hand, December 31, 1917			$9 584.82

FINANCIAL CONDITION AT CLOSE OF FISCAL YEARS 1913–1917 INCLUSIVE.

Fiscal Year.	Assets.			Liabilities.	Deficit or Surplus.	
	Cash Balance.	Accounts Receivable.	Total.	Accounts Payable.	Deficit.[a]	Surplus.
1913	$1 139.87	$662.19	$1 802.06	$5 393.01	$3 590.95	......
1914	43.57	1 044.74	1 088.31	6 421.27	5 332.96	......
1915	103.54	1 481.80	1 585.34	7 992.37	6 407.03	......
1916	845.78	2 595.24	3 441.02	300.93[b]	......	$3 140.09[c]
1917	9 584.82	2 601.71	12 186.53	231.00[b]	......	11 955.53[c]

[a] This deficit includes a reserve for uncollected membership dues for the respective years as follows: $874.50; $765; $813.
[b] These sums represent dues paid in advance and do not include any unpaid bills.
[c] These items include $1,300.00 on account of Life Memberships.

Receipts from Sales of Publications.—The receipts in 1917 from the sales of publications amounted to $5573.41 and the receipts from the sale of rights for one year to reprint certain Standards of the Society were as follows:

Carnegie Steel Company	$250.00
R. W. Hunt and Co	100.00
Jones & Laughlin Steel Company	250.00
National Tube Company	100.00
Portland Cement Association	250.00
Southern Pine Association	250.00
Total	$1200.00

The returns from the sales of publications ($5573.41) practically equal the largest returns for any previous year (1915, $5620.44) and are $1107.25 in excess of the returns from this source reported last year. No statistics of the Society are perhaps more significant of the weight and standing to which it has attained than this gratifying record of growing revenue from the sale of its own publications which has now been consistently maintained for many years. The largely increased demand for A.S.T.M. Standards in relation to the purchase of war materials is indicative of the importance of its work in the present national emergency.

Inventory and Cost of Publications in Stock.—In the foregoing financial analysis no account has been taken of the assets of the

Society in the form of publications in stock. The inventory of the Proceedings on May 1, 1918, is as follows:

VOLUME.	COPIES.	VOLUME.	COPIES.	VOLUME.	COPIES.
I	12	VIII	397	XIV, Part II	562
II	120	IX	523	XV, Part I	392
III	17	X	438	XV, Part II	362
IV	142	XI	398	XVI, Part I	369
V	315	XII	141	XVI, Part II	370
VI	648	XIII	460	XVII, Part I	274
VII	386	XIV, Part I	570	XVII, Part II	266

Total stock of Proceedings, 7162 volumes.

The stock of publications in general may be summarized as follows, the prices approximating their original manufacturing cost:

Proceedings	7162 copies at $1.50	$10 743.00
Index (Vols. I–XII incl.)	743 copies at 0.50	371.50
Reports of Committee D-1 (1903-1914 incl.)	367 copies at 1.75	642.25
Total cost of publications in stock		$11 756.75

Proposed Amendment of the By-Laws.—The Executive Committee recommends the following changes in the by-laws. The proposed amendments affecting Art. VI have been previously approved by Committee E-5 on Standing Committees:

ARTICLE II. OFFICERS AND THEIR ELECTION.

SEC. 5.—Add the following new paragraph to Section 5:

"The Executive Committee shall also be empowered to elect an Assistant Secretary at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary shall be fixed by the Executive Committee."

ARTICLE III. NOMINATION OF OFFICERS.

SEC. 2.—For the sixth sentence, which reads:

"The members of the nominating committee for the

> previous year shall not be eligible for appointment on this committee for the immediately succeeding year.",

substitute:

> "The members of the nominating committee for a given year shall not be eligible for appointment on this committee for the immediately succeeding year."

ARTICLE VI. PROCEDURE GOVERNING THE ADOPTION OF STANDARDS.

SEC. 1.—Strike out the second and third paragraphs, which read:

> "Proposed new standards or proposed amendments of existing standards shall be presented at the Annual Meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Proceedings under a section designated 'Tentative Standards,' on which written discussions addressed to the appropriate committee shall be invited. If introduced in an even year such tentative standards shall be published for two years, and if introduced in an odd year they shall be published for one year. At the Annual Meeting in the next even year following their introduction, such tentative standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.
>
> "The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or two years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the Annual Meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.",

and substitute:

"Proposed new standards shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting. On two-thirds vote of those voting, they shall be printed, as presented or as amended, in the Proceedings and separately under the title 'Tentative Standards,' on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting tentative standards shall be subject to amendment by a two-thirds vote of those voting. They may then be referred, by a like vote, to letter ballot of the Society, in which case a two-thirds vote of those voting shall be required for adoption; or, on the recommendation of the committee concerned, they may be continued as tentative, as printed or as amended, in which case the above prescribed procedures shall apply at any succeeding annual meeting.

"Proposed amendments of existing standards shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting. On two-thirds vote of those voting they shall be printed, as presented or as amended, in the Proceedings as part of the report of the appropriate committee; and collectively under the same cover with the Tentative Standards for that year. At any succeeding annual meeting they shall be subject to amendment by a two-thirds vote of those voting; and at the annual meeting in the year in which the book of A.S.T.M. Standards will next be published, they shall be subject to reference by a like vote to letter ballot of the Society, in which case a two-thirds vote of those voting shall be required for adoption.

"The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or more years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected."

Resolution Referred to the Executive Committee by Action of the Society.—At the last annual meeting of the Society, a resolution was adopted:

> "That the Executive Committee be requested to give consideration to the general subject of the formation of and methods of procedure to be followed by joint committees and the publication of joint reports; whether these joint committees be made up from various committees of this Society or of representatives of this Society and other societies and organizations."

In pursuance of this resolution a sub-committee of the Executive Committee was appointed to report on this subject to the Executive Committee. Its report, recommending the addition of two new paragraphs to the section on "Cooperation with Other Committees" in the Regulations Governing Standing Committees,[1] was then referred to Committee E-5 on Standing Committees for consideration and advice. Committee E-5 approved these proposed additions to the Regulations Governing Standing Committees but recommended certain minor changes. Upon reconsideration, the Executive Committee concluded that it would be unwise to confirm their previous action by the adoption of the report of the original sub-committee with the proposed slight amendments recommended by Committee E-5.

The Executive Committee further concluded that action on the proposed additions to the Regulations Governing Standing Committees, as embodied in the proposed new Section 20 entitled "Regulations Governing Cooperative Relations,"[2] had better be deferred pending further developments in certain closely related matters, notably the completion of the proposed final report of the American Engineering Standards Organization Committee to the proposed five founder societies, including the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the American Society for Testing Materials, to which reference is made elsewhere in this report.

[1] For the wording of these two paragraphs see Appendix to this report, p. 97, "Regulations Governing Cooperative Relations."

[2] *Loc. cit.*

Request of Committee C-2 on Reinforced Concrete that the Executive Committee Invite Certain Other Societies to Cooperate with Committee C-2.—The Executive Committee has been requested by Committee C-2 on Reinforced Concrete to invite certain other societies to cooperate through individual committees with Committee C-2 in the preparation of proposed Standard Specifications for Reinforced Concrete.

It is the feeling of the Executive Committee that action on this request cannot consistently be taken until it is prepared to adopt a definite policy on the general subject of the resolution introduced at the last annual meeting, concerning "the formation of and methods of procedure to be followed by joint committees and the publication of joint reports, etc.," referred to elsewhere in this report. The Executive Committee has accordingly deferred action on the request of Committee C-2 pending its final consideration of this resolution.

Proposed American Engineering Standards Committee.—In August, 1916, the Society was invited by the American Institute of Electrical Engineers to appoint three representatives on a proposed Joint Committee consisting of three representatives each from the following five societies: American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and American Society for Testing Materials; to consider ways and means of bringing about cooperation in American Engineering Standards. This invitation was accepted and Mr. A. A. Stevenson, Mr. J. A. Capp and the Secretary-Treasurer were appointed as the representatives of the Society. They were later empowered, in pursuance of a recommendation from the Joint Committee, to represent the Society in the development by the Joint Committee of a scheme of organization of a proposed American Engineering Standards Committee, with the understanding that by this action the Society is not committed in advance to permanent participation in the proposed organization.

At the meeting of the Executive Committee in June, 1917, a report from the Joint Committee, containing a proposed scheme of organization of an American Engineering Standards

Committee, was presented. A sub-committee of five—two in addition to the three A.S.T.M. representatives on the Joint Committee—was appointed to study this report and to present its recommendations to the Executive Committee.

After further careful consideration of this subject at the meeting of the Executive Committee in October, 1917, the following resolutions were adopted and transmitted to the chairman of the Joint Committee:

> 1. That the Executive Committee of the American Society for Testing Materials is interested in the plan for the proposed organization of an American Engineering Standards Committee;
>
> 2. That it hereby reappoints the three present representatives of the Society on the Joint Committee on the Organization of an American Engineering Standards Committee;
>
> 3. That the report of the Joint Committee on the Organization of an American Engineering Standards Committee submitted under date of June 19, 1917, does not, as it stands, constitute a satisfactory basis for final action by the Executive Committee of the American Society for Testing Materials;
>
> 4. That the proposals set forth by this report should in some respects be amended, and be sufficiently expanded to define the full purpose of the Joint Committee, so far as this may affect the work and responsibilities of the American Society for Testing Materials.

At its next meeting in January, 1918, the Executive Committee passed the following resolutions, in pursuance of recommendations from the sub-committee of five previously referred to:

> 1. That the American Society for Testing Materials will continue to cooperate with the Organization Committee in its efforts to perfect an organization to be known as the American Engineering Standards Committee; it being assumed that there is nothing in the purpose of the Organization Committee which, if made effective, can operate to interfere with or inhibit the activities of the American Society for Testing Materials in the development of standards in its particular field;

2. That it is assumed to be self-evident that the American Society for Testing Materials cannot commit itself to any definite scheme of action until the scheme itself shall have been given definite form, and until the other participating organizations shall have taken such action as may be necessary to their active participation in the scheme proposed;

3. That it is suggested that the purposes of the proposed American Engineering Standards Committee may best be developed under the auspices of the recently organized Engineering Council, and it is recommended that the Organization Committee get into communication with that body with a view of developing means whereby the purposes of the proposed American Engineering Standards Committee may become one of the functions of the Engineering Council.

These resolutions were sent to the chairman of the Organization Committee, together with a number of suggested changes in the proposed scheme of organization. After careful consideration of these and other suggestions, the Constitution and Rules of Procedure of the proposed American Engineering Standards Committee were revised and adopted by the Organization Committee at a meeting held on May 4, 1918, and have been referred to the governing boards of the five proposed founder societies.

This entire matter will accordingly be carefully considered by the Executive Committee at its next meeting, which will be held on the afternoon of Wednesday, June 26, during the annual meeting.

Translation of Certain Standards into Foreign Languages by the U. S. Department of Commerce.—As announced in the two previous annual reports of the Executive Committee, arrangements have been made with the U. S. Department of Commerce by which those standards of the Society having an important bearing on the requirements of export trade will be translated into foreign languages by the Department of Commerce without expense to the Society, with a view of distributing these standards among the U. S. Consular offices and making

them available at moderate prices to American manufacturers and others interested in foreign trade.

Of the 107 Standards of the Society 99 have been translated into Spanish. Of these one, namely, the Standard Specifications and Tests for Portland Cement (C 9–17) has been approved for printing and is expected to be available for distribution shortly. The following 13 Standards are now being set in type:

Standard Specifications for:

- Carbon-Steel Rails (A 1–14);
- Open-Hearth Steel Girder and High Tee Rails (A 2–12);
- Low-Carbon-Steel Splice Bars (A 3–14);
- Medium-Carbon-Steel Splice Bars (A 4–14);
- High-Carbon-Steel Splice Bars (A 5–14);
- Structural Steel for Bridges (A 7–16);
- Structural Steel for Buildings (A 9–16);
- Structural Steel for Locomotives (A 10–16);
- Carbon-Steel Bars for Railway Springs (A 14–16);
- Carbon-Steel and Alloy-Steel Forgings (A 18–16);
- Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars (A 19–16);
- Carbon-Steel Forgings for Locomotives (A 20–16);
- Carbon-Steel Car and Tender Axles (A 21–14).

The remaining 85 standards are being finally edited and will be printed as nearly as possible in the order agreed upon when this work was instituted in 1915.

Reference to the copyright in English of the A.S.T.M. Standards will appear in these publications.

Assistance on the Part of the Society to the Government in Matters Relating to the War.—As stated in the last annual report of the Executive Committee the Society pledged its support and offered its services to the Government in the national emergency through a letter addressed in April, 1917, to the President of the United States by the President of the Society. The following facts may be briefly recorded as indicating wherein the Society has rendered assistance during the past year in matters relating to the war:

The International Aircraft Standards Board has in a number of instances adopted A.S.T.M. Standards as the standards of that Board, and in other instances used A.S.T.M. Standards as a basis for their own.

The Society was invited by the British Engineering Standards Committee to be represented at an Anglo-American Aircraft Conference in London, to which delegates had been invited from the U. S. Army, the U. S. Navy, the U. S. Bureau of Standards, the International Aircraft Standards Board, the Manufacturers' Aircraft Association, the American Society of Mechanical Engineers, and the Society of Automotive Engineers. The Executive Committee accepted this invitation and appointed Mr. Albert Ladd Colby to represent the Society at that conference in matters affecting materials and testing. Mr. Colby spent a period of some eleven weeks abroad on this work, rendering very efficient and effective service on behalf of the Society. It is hoped that an opportunity will be afforded at this annual meeting for the presentation of a brief report from Mr. Colby.

The Society has submitted detailed information concerning its activities to the office of the Director General of Railroads, at the request of certain interested departments.

At the invitation of the Engineering Bureau, Office of Chief of Ordnance, U. S. A., announcement was made through a circular to members of the opportunities for active service in the Trench Warfare Section of the Ordnance Department, and members of the Society interested in this matter were invited to apply for a Commission in Ordnance Officers' Reserve Corps. This announcement resulted in a relatively small number of applications, which were promptly referred to the Office of Chief of Ordnance.

The Executive Committee has authorized a discount, for the duration of the war, of twenty per cent from list prices on all orders for the publications of the Society emanating from Government departments.

As emphasized previously in this report, the Executive Committee believes that the most effective service the Society can render to the Government in the present emergency is to maintain the activities of its standing committees, whose work —especially that relating to the preparation of standards—is of

such great importance to manufacturing interests and to industrial affairs in general.

Members in Military Service.—Many members of the Society have entered the active military service of the Government. The Executive Committee has decided that the dues of such members shall be suspended during the period of their service; and while in that service the members shall retain all the privileges of the Society, including the receipt of its publications, for which they may apply on their return from military service. The dues of members who enter the civil and non-active military service of the Government, however, shall not be subject to change, for the reason that the Society has always had members in these branches of the service and the Executive Committee does not believe it would be right to treat differently those who now enter such service.

The Executive Committee has also decided to publish in future issues of the annual membership pamphlet a separate list of "Members in Military Service," in addition to the publication of these names in the regular list of members; and to issue a List of Members in Military Service in connection with circulars to members at suitable intervals throughout the duration of the war. The first list was issued on May 29, and contains the names of 140 members who have advised the Secretary-Treasurer that they are in the military service.

Respectfully submitted on behalf of the Executive Committee,

WM. H. BIXBY,
President.

EDGAR MARBURG,
Secretary-Treasurer.

EDITORIAL NOTE.

The proposed amendments of the By-Laws referred to in the report of the Executive Committee (pages 73–75), were further amended at the annual meeting as indicated in the Summary of the Proceedings, pages 11–12, and adopted by letter ballot of the Society on August 26, 1918. The By-Laws in their amended form appear on pages 9–16 of the 1918 Membership Pamphlet.

The final report of the joint committee appointed to develop a scheme of organization of a proposed American Engineering Standards Committee, referred to in the report of the Executive Committee (pages 77–79), was considered by the Executive Committee at a meeting on June 26. The Executive Committee approved the scheme of organization as set forth in the Constitution and Rules of Procedure of the proposed American Engineering Standards Committee (see pages 46–51) embodied in the report, and recommended to the Society at the Sixth Session of the annual meeting that the following resolution be referred to letter ballot of the Society (see Summary of the Proceedings, pages 25–26):

> "*Resolved*, That the American Society for Testing Materials approves the scheme of organization of the proposed American Engineering Standards Committee, as outlined in the Constitution and Rules of Procedure submitted, and agrees to participate as a founder, as recommended by the Executive Committee."

This resolution was adopted by letter ballot of the Society on August 26, 1918.

APPENDIX.

ABSTRACT OF THE MINUTES OF THE EXECUTIVE COMMITTEE.

REGULAR MEETING, June 27, 1917.—Hotel Traymore, Atlantic City, N. J. Present: Vice-President, S. S. Voorhees; Past-Presidents, A. W. Gibbs, Mansfield Merriman and A. A. Stevenson; Members of Executive Committee, W. H. Bassett, John Brunner, J. A. Capp, W. F. M. Goss, W. M. Kinney and G. W. Thompson.

A communication from President Bixby was read announcing the appointment of the following members on the Finance Committee: Past-President A. W. Gibbs, Chairman, G. W. Thompson and Mr. W. H. Bassett.

The Secretary-Treasurer reported that favorable action had been taken on 74 new applications for membership; that six members had resigned; and that the Society had suffered the loss by death of three members, making the total membership in the Society on June 27, 1917, 2167.

It was reported that on the recommendation of Committee E-5, Committee A-3 had approved of the change in its title from "On Cast Iron and Finished Castings" to "On Cast Iron," but that a recommendation to Committee C-10 that its title be changed from "On Hollow Building Tile" to "On Hollow Building Blocks" had met with negative action by that committee.

A letter under date of April 13 from Mr. L. W. Page, chairman of Committee D-4 on Road Materials, was presented, requesting the Executive Committee to appoint a joint conference committee consisting of members of that committee and Committee C-3 on Brick to consider the adoption of new tests for paving brick. Subsequent correspondence indicated that the committee had also taken the matter up with Committee C-3. Past-President Talbot reported informally on behalf of Committee C-3 that that committee had appointed a sub-committee to confer with Committee D-4.

Voted that the matter be laid on the table pending further representations on the part of either Committee D-4 or Committee C-3.

Attention was called to the following motion passed at the first session of the annual meeting:

> "That the Tentative Standards be published in the Proceedings as heretofore, and that the Executive Committee be requested to take such action as they may see fit with regard to the separate publication of the Tentative Standards."

Voted on motion of Mr. Capp to refer with power to the Chairman of the Finance Committee and the Assistant to the Secretary, the question of the publication of the Tentative Standards in a separate pamphlet, as well as the publication of each Tentative Standard in separate form; also as to the size of these editions.

A communication under date of June 19 to the governing boards of the A.S.C.E., A.S.M.E., A.I.M.E., A.S.T.M. and A.I.E.E. from Mr. C. A. Adams,

Chairman of the Joint Committee on the Organization of an American Engineering Standards Committee, was presented together with the report of the Joint Committee which included a proposed scheme of organization.

It was stated that copies of this letter and report had been mailed to every member of the Executive Committee.

Past-President Stevenson and Mr. Capp, two of the three representatives of the Society on the Joint Committee, reported verbally on this subject.

Voted that a sub-committee of five—two in addition to the present three A.S.T.M. representatives on the Joint Committee—be appointed to study this report; to secure the opinions of the members of the Executive Committee and of all the Past-Presidents of the Society; and to present its report to the Executive Committee at the next quarterly meeting, or earlier if deemed advisable, at an adjourned meeting.

A letter to the President from Mr. D. K. Boyd, Editor of the Structural Service Department of the American Institute of Architects, was presented, in which he called attention to the above department in the Journal of the A.I.A., acknowledging the cooperation already extended by the Society and soliciting a continuation of the same. No action in this matter was deemed necessary but it was decided to advise Mr. Boyd that the Society is always ready to cooperate to the fullest practicable extent.

Voted that if the four proposed standards presented at the annual meeting for reference to letter ballot of the Society are adopted by the Society, they shall be furnished with the 1916 book of A.S.T.M. Standards without additional charge, and that they shall also be furnished without charge to the members of the Society in separate pamphlet form.

REGULAR MEETING, October 9, 1917.—Engineers' Club, Philadelphia. Present: President, Gen. Wm. H. Bixby; Past-President, A. W. Gibbs; Members of Executive Committee, W. H. Bassett, W. M. Kinney, G. W. Thompson, F. E. Turneaure, and C. D. Young; Secretary-Treasurer, Edgar Marburg.

The Secretary-Treasurer reported that favorable action had been taken on 63 new applications for membership; that one member had resigned; and that the Society had suffered the loss through death of 4 members, making the total membership on September 29, 1917, 2225.

The semi-annual report of the auditors was presented and ordered spread on the minutes:

JOHN HEINS AND CO.,
Public Accountants and Auditors,
Philadelphia.

July 17, 1917.

Mr. Edgar Marburg, Secretary-Treasurer,
American Society for Testing Materials,
Philadelphia, Pa.

Dear Sir:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended June 30, 1917, and found the accounts to be correct, and to be in their usual excellent condition.

We submit balance sheet as of June 30, 1917, as also a statement of cash receipts and disbursements for the six months then ended.

Respectfully submitted,

(Signed) JOHN HEINS AND CO.

A letter was presented on behalf of the Finance Committee containing the following recommendations in the matter of dues during the period of the war, which had been referred to that committee by the Executive Committee:

"The Finance Committee, after conference and after consideration of the action of several other societies upon this question, recommends:

"'That the dues of members who enter the active military service of the Government, and so notify the Secretary-Treasurer, shall be suspended during the period of such service; and that while in such service the members shall retain all the privileges of the Society, including its publications, for which they may apply upon their return from military service."

"The Finance Committee does not recommend any change in the dues of members entering the civil and non-active military service of the Government, for the reason that the Society has always had members in these branches of the service, and the committee does not believe it would be right to treat differently those now entering such service."

Voted that the above mentioned recommendation of the Finance Committee be adopted and that it be announced in the next circular to members.

On motion it was decided to recommend, in due course, the following amendment of the by-laws on behalf of the Executive Committee: Art. III, Sec. 2, 18th line from top, substitute "a given year" for "the previous year," this amendment being offered with a view of correcting the present ambiguity.

A request under date of July 10, 1917, from Mr. L. W. Page, Chairman, Committee D-4 on Road Materials, for an interpretation of the word "acquiescence" in paragraph 1 of the section on "Appointments" in the Regulations Governing Standing Committees was, on motion, referred to Committee E-5 for consideration and report to the Executive Committee.

In connection with the question of issuing reprints of the reports of Committee D-1 in a separate volume and in such a form as to include the reports for 1915–16–17 with the previously issued edition of the reports for 1903–14, an approximate cost estimate was presented in pursuance of which it was voted as the sense of the meeting that it would be inexpedient to take affirmative action in this matter.

The following report of Mr. W. H. Fulweiler and Mr. L. H. Kenney, tellers, was presented relative to the results of the letter ballot following the annual meeting:

Proposed Amendment of the By-Laws:	*Aye*	*Nay*	*Not Voting*
Article II, Section 3	322	0	74
Article III, Section 2	322	0	74

PROPOSED NEW STANDARDS.

	Aye	Nay	Not Voting
Tests for:			
1. Paint Thinners other than Turpentine	113	3	280
2. Shellac	101	2	293
Methods for:			
3. Routine Analysis of White Pigments (as amended at annual meeting)	104	2	290
4. Sampling and Analysis of Creosote Oil	92	15	289
Total number of legal votes cast	396		

As a matter of information a letter was presented from Mr. J. A. Mathews, under date of July 18, to the effect that among an advisory committee of seven members responsible for the metal materials for Government aeroplanes, five, viz., W. H. Bassett, H. L. Greene, H. J. Horn, J. A. Mathews and K. W. Zimmerschied, are members of the A.S.T.M.

The Secretary-Treasurer presented some recent correspondence with the International Aircraft Standards Board, from which the following is quoted: "It is the intention of the Board, if there is no objection, to adopt these standards (certain previously enumerated A.S.T.M. Standards) as I.A.S.B. ones, with a reference giving credit to the A.S.T.M."

The Secretary-Treasurer was authorized to say in reply that the proposed procedure has the approval of the Executive Committee.

Announcement was made that the President had appointed Past-President A. A. Stevenson and Mr. C. L. Warwick as the representatives of the Society in connection with a proposed census and listing of engineers to be made by the American Engineering Service of the Engineering Council.

In relation to the following resolution adopted at the last annual meeting:

> "That it is the sense of the members present at this meeting that the Executive Committee be requested to give consideration to the general subject of the formation of and methods of procedure to be followed by joint committees and the publication of joint reports; whether these joint committees be made up from various committees of this society or of representatives of this Society and other societies and organizations.",

it was voted that the President be authorized to appoint a committee to recommend to the Executive Committee, if possible, a definite line of policy on the general subject of the resolution, and incidentally to report whether the policy that may be recommended is consistent with the present Regulations Governing Standing Committees, or, if not, to point out how the latter may be reconciled with the former.

A letter under date of June 19, 1917, from Mr. C. A. Adams, Chairman of the Joint Conference Committee to consider the organization of an American Engineering Standards Committee, directed to the governing boards of the A.S.C.E., A.S.M.E., A.I.M.E., A.I.E.E. and A.S.T.M., with an accompanying copy of the report of the Joint Committee on a scheme of organization of an American Engineering Standards Committee, was presented. The Secretary-Treasurer reported that, in pursuance of earlier action on the part of the Executive Committee, copies of this report had been

sent by a sub-committee of five of the Executive Committee, which included the three A.S.T.M. representatives on the Joint Committee, to every Past-President and present officer of the Society whose replies in complete and in condensed form were now available. The condensed replies were then read in full.

After considerable discussion, the following resolutions were adopted, with the understanding that they would be transmitted to the proper official quarters:

Resolved:

1. That the Executive Committee of the American Society for Testing Materials is interested in the plan for the proposed organization of an American Engineering Standards Committee;

2. That it hereby reappoints the three present representatives of the Society on the Joint Committee on the Organization of an American Engineering Standards Committee;

3. That the report of the Joint Committee on the Organization of an American Engineering Standards Committee submitted under date of June 19, 1917, does not, as it stands, constitute a satisfactory basis for final action by the Executive Committee of the American Society for Testing Materials;

4. That the proposals set forth by this report should in some respects be amended, and be sufficiently expanded to define the full purpose of the Joint Committee, so far as this may affect the work and responsibilities of the American Society for Testing Materials.

The Secretary-Treasurer announced that a request had been received from Committee C-2 on Reinforced Concrete that the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association be each invited to cooperate through individual committees with Committee C-2 in the preparation of proposed Standard Specifications for Reinforced Concrete.

After some discussion it was voted that this request be laid on the table, without prejudice, pending action on the report of the committee which the President has been authorized to appoint with instructions to report its recommendations to the Executive Committee, on a definite line of policy on the general subject of the resolution introduced at the last annual meeting concerning "the formation of and methods of procedure to be followed by joint committees and the publication of joint reports, etc."

REGULAR MEETING, January 15, 1918.—United Engineering Building, New York City. Present: Vice-President, S. S. Voorhees; Past-Presidents, Mansfield Merriman; A. A. Stevenson; Members of Executive Committee, W. H. Bassett, J. A. Capp, W. M. Kinney, C. D. Young (represented by proxy by G. Aertsen).

In the absence, by direction of his physician, of the Secretary-Treasurer, he was represented by Mr. C. L. Warwick, Assistant to the Secretary.

The Secretary-Treasurer reported that favorable action had been taken on 33 new applications for membership; that 48 members had resigned, making the total membership in the Society on December 31, 1917, 2210.

The semi-annual report of the auditors was presented and ordered spread on the minutes:

JOHN HEINS AND CO.
Public Accountants and Auditors,
Philadelphia.

January, 2, 1918.

Mr. Edgar Marburg, Secretary-Treasurer,
American Society for Testing Materials,
Philadelphia, Pa.

Dear Sir:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1917; having previously made a similar audit and report for the preceding six months ended June 30, 1917, and at both audits found the accounts to be correct, and to be in their usual excellent condition.

We submit balance sheet as of December 31, 1917, as also a statement of operations for the twelve months then ended, schedules of accounts receivable, etc.

Respectfully submitted,

(Signed) JOHN HEINS AND CO.

On motion it was decided to recommend the following amendment of the by-laws:

Art. II, Sec. 2.—Add the following new paragraph:

The Executive Committee shall also be empowered to elect an Assistant Secretary at any time and for such a term as they may deem necessary. The duties and the salary of the Assistant Secretary shall be fixed by the Executive Committee.

Attention was called to the fact that, in pursuance of action taken a year ago, the traveling expenses of the members of the Executive Committee, incidental to their attendance at meetings of that committee, except such meetings as may be held in connection with the annual meeting, will be defrayed by the Society, commencing with this meeting, and that the Secretary-Treasurer desired instructions as to the form in which this payment should be made, whether on a mileage basis or by the submission of a voucher of expenses by the members in attendance at the meetings.

Voted that these expenses shall be paid on the basis of a voucher of expenses to be rendered to the Secertary-Treasurer's office by the members attending the meetings of the Executive Committee.

It was decided to accept the invitation of the British Engineering Standards Committee to appoint a representative of the American Society for Testing Materials as a delegate to a prospective International Aircraft Conference at an unnamed date in the early future, with the understanding:

1. That the representative of the American Society for Testing Materials at this conference is not authorized to voice any opinion on behalf of the American Society for Testing Materials as a body;

2. That the representative of the American Society for Testing Materials is authorized to express himself freely at the conference relative to matters affecting materials and testing, but that in these matters also he will speak on his personal responsibility and not on that of the Society as a whole;

3. That the representative of the American Society for Testing Materials is not authorized to participate in his representative capacity in the discussion of any technical matters other than those relating to materials and tests; thus, he is not empowered to take part in the consideration of such questions as, for example, the standardization of units of measurement, the standardization of screw threads, etc.

It was voted to appropriate a sum not exceeding $750 for defraying the expenses of the representative of the Society in attendance at the proposed Anglo-American Aircraft Conference in London.

A form of questionnaire, sent by the Secretary-Treasurer to all members reporting their entrance into active military service, was submitted. A few revisions were made in this form and it was decided to send the questionnaire to every member of the Society by first-class mail.

It was also decided to publish in the membership pamphlet, in a separate list under a suitable title, the names of all members in military service and at the same time to retain their names in the regular membership list.

Voted to grant to Government departments and bureaus, for the duration of the war, a discount of 20 per cent on all orders for the publications of the Society, this being the same discount allowed to bookdealers and public libraries.

Announcement was made that the President had appointed Mr. S. W. Stratton and Vice-President S. S. Voorhees as the representatives of the Society at a conference in Washington on October 26, 1917, for the purpose of coordinating the activities of the engineering societies and war committees in Washington, as well as of the appointment of Mr. F. J. Cole as the representative of the Society at a public hearing on December 7, 1917, of the American Society of Mechanical Engineers for the discussion of the Power Code Tests of that society.

A letter was presented under date of November 23, 1917, from Mr. Enrique Touceda recommending the creation of a new standing committee on Malleable Castings. This communication had been referred by the Secretary-Treasurer to Mr. Richard Moldenke, Chairman of Committee A-3 on Cast Iron, which has among its sub-committees one on malleable castings. Mr. Moldenke replied under date of January 3, 1918, approving Mr. Touceda's proposal for the creation of a separate committee on this subject.

Voted that the creation of a new standing committee on Malleable Castings be authorized and that the appointments on the committee, including the temporary chairmanship, be left with power to the President and the Secretary-Treasurer, in accordance with the usual procedure in such matters.

The Assistant to the Secretary reported briefly on the progress in the translation into foreign languages of certain standards of the Society by the Department of Commerce in pursuance of an agreement entered into early in 1916. He stated that the only standard which had been put in type was that for Portland Cement (C 9–17) of which proofs of the English-Spanish edition had been sent to and approved by the Secretary-Treasurer.

The following report by the Secretary-Treasurer in re Committee E-3 on Revision of Pipe Threads was presented:

1. This committee (created in 1915) is a joint committee consisting of representatives of the Am. Soc. Mech. Engrs., Master Car Bldrs' Assoc., Am. Gas Inst., Ry. Signal Assoc., Mfrs. Assoc. on Standardization of Fittings, and the Am. Soc. Test. Mats.

2. While the committee has done considerable experimental work, it has as yet presented only a single report (1917), which contains no specific recommendation for action by the Society. This report was accepted for publication and appears in the *Proceedings*, Vol. XVII, Part I, pp. 504–507.

3. It appears that a committee of the American Society of Mechanical Engineers on the same general subject of screw threads has been in existence longer than the A.S.T.M. committee. It appears further that this subject does not fall very obviously in the field of the A.S.T.M. as defined in the Charter, viz., "The Promotion of Knowledge of the Materials of Engineering, and the Standardization of Specifications and the Methods of Testing."

4. The continuation of this joint committee, practically paralleling a committee of the A.S.M.E., would seem to be—to say the least—of questionable value.

5. The chairman of the A.S.T.M. Committee E-3, Mr. H. V. Wille, is willing to support a recommendation from the Secretary-Treasurer to the Executive Committee that Committee E-3 be invited to consider the desirability of its discontinuation under the auspices of the A.S.T.M., with a view of effecting an arrangement for the continuation of the work under the auspices of the A.S.M.E.

6. The Secretary of the A.S.M.E. has stated in a letter under date of January 10, that, in his judgment, the A.S.M.E. and the A.S.M.E. committee on pipe threads would view favorably the proposal as outlined in paragraph 5.

Voted that the report of the Secretary-Treasurer be approved and that he be authorized to take steps towards carrying out the proposals contained in paragraph 5.

The committee consisting of Past-President A. A. Stevenson and Mr. C. L. Warwick, appointed by the President to represent the Society on the American Engineering Service Committee of the Engineering Council, reported that it has kept in close touch with that committee in its work of compiling a general index of engineers and that the A.E.S. committee has now under consideration certain recommendations from the A.S.T.M. committee that, in the future, duplication as between various societies be avoided by the preparation of a composite catalogue of the four founder societies of the Engineering Council, and that future circularizing be done through the A.E.S. committee rather than through the various individual societies. The committee recommended that it be discharged and that the Secretary-Treasurer be requested to keep in touch with future developments in this matter.

Voted that the report of the committee be accepted and its recommendations approved.

The report of the tellers—Mr. H. C. Berry and Mr. W. H. Kavanaugh—on recommendations for appointments on the nominating committee for officers was presented in summary, the complete report being available in full detail for reference purposes.

Voted that in addition to the last three Past-Presidents, who are ex-officio members of the Nominating Committee, the following appointments on that committee be made:

Members.	*Alternates.*
Ashton, Ernest	Boyer, E. D.
Gibboney, J. H.	Walker, P. H.
Kenney, E. F.	Fry, L. H.
Lynch, T. D.	McLeod, John.
Thompson, S. E.	Hatt, W. K.
Waring, F. M.	Speller, F. N.

NOTE.—Every member and alternate in this list had received five or more votes.

Voted to authorize the President and Secretary-Treasurer to fill any vacancies due to the inability of both the member and his alternate to serve on the Nominating Committee.

On motion it was decided to hold the next annual meeting of the Society at the Hotel Traymore, Atlantic City, N. J., during the week commencing June 24, 1918.

A letter was presented from the Secretary of the American Society of Civil Engineers, enclosing a copy of resolutions adopted by the Executive Committee of the Board of Direction of that Society, appealing to Congress to repeal certain sections of the 1917 War Revenue Act. This letter expressed the hope that the A.S.T.M. would "do everything possible to secure the repeal of this unjust provision of law."

The Secretary-Treasurer was instructed to advise the Secretary of the A.S.C.E that it is contrary to the policy of the Society to interest itself actively in legislative matters.

A communication from Committee A-1 was presented, recommending that the Executive Committee of the Society invite the American Electric Railway Engineering Association to appoint a committee to cooperate with Committee A-1 in the consideration of the revision of the Standard Specifications for Open-Hearth Steel Girder and High Tee Rails (Serial Designation A 2–12) by the substitution of a Brinell impression test for the drop test.

Voted that the Secretary-Treasurer be instructed to invite the A.E.R.E.A. to appoint such a committee.

The following recommendations of Committee E-5 on matters affecting the Regulations Governing Standing Committees, including the amendment of Art. VI of the by-laws, which had been referred to that committee, for consideration and advice, by the Executive Committee, were approved:

(*a*) That the last clause in paragraph 1 of the section on "Appointments" be changed to read from "to predominate with the acquiescence of the former" to "to predominate by majority vote of the former."

(*b*) Substitute the following for the present paragraph 8 of the section on "Standards":

The annual reports of the standing committees shall be transmitted to the Secretary-Treasurer of the Society as early in the calendar year as possible and not less than eight weeks in advance of the date of the annual meeting. Preprints of these reports shall be mailed by the Secretary-Treasurer to every member of the Society at the earliest possible subsequent date and not

less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such reports and that members not intending to be present at the meeting may contribute discussions by letter.

(*c*) Substitute the following for the present "Procedure Governing the Adoption of Standards" in Art. VI of the by-laws and in the section on "Standards" in the Regulations Governing Standing Committees:

Proposed new standards or proposed amendments of existing standards shall be presented at the annual meeting. At this meeting amendments may be made by a two-thirds vote of those voting. Proposed new standards, as presented or as amended, shall be published, on two-thirds vote of those voting, in the Proceedings and separately under the title Tentative Standards, on which written discussions addressed to the appropriate committee shall be invited. Proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Proceedings as part of the report of the appropriate committee; and on the recommendation of the committee, among the Tentative Standards. If introduced in an even year such tentative standards or proposed amendments of existing standards shall be published for two years, and if introduced in an odd year they shall be published for one year.

At the annual meeting in the next even year following their introduction, such tentative standards or proposed amendments of existing standards may be amended by a two-thirds vote of those voting. They may then be referred by a like vote to letter ballot of the Society, in which case a two-thirds vote of those voting shall be required for adoption; or they may be continued as tentative for another year, on recommendation of the committee concerned, approved by majority vote of those voting at the annual meeting. In that case the above prescribed procedure as to amendments, as to reference to letter ballot and as to adotpion, or as to further continuation as tentative, shall apply for that and any succeeding year; except that proposed amendment of existing standards shall be subject to adoption only in the even years.[1]

Past-President A. A. Stevenson brought up for consideration the desirability of publishing the book of A.S.T.M. Standards triennially instead of biennially. After considerable discussion it was voted to refer this matter to Committee E-5 for consideration and advice, with the request that it present its recommendations to the Executive Committee at its next quarterly meeting; and that in case its recommendations should favor the triennial publication of the book of A.S.T.M. Standards, to submit for consideration any revisions in the Regulations Governing Standing Committees which may be necessary.

The sub-committee of five, which had been appointed to act in an advisory capacity to the Executive Committee in the matter of the proposed organization of an American Engineering Standards Committee, reported that it had held a meeting in NewYork on January 5, and that it had agreed to recommend to the Executive Committee that the chairman of the Organizing Committee of the proposed American Engineering Standards Committee be advised:

1. That the A.S.T.M. will continue to cooperate with the Organization Committee in its efforts to perfect an organization to be known as the American Engineering Standards Committee; it being assumed that there is nothing in the purpose of the Organization Committee which, if made effec-

[1] For final revision of these paragraphs of the Regulations Governing Standing Committees, see p. 96.—ED.

tive, can operate to interfere with or inhibit the activities of the A.S.T.M. in the development of standards in its particular field.

2. That it is assumed to be self-evident that the A.S.T.M. cannot commit itself to any definite scheme of action until the scheme itself shall have been given definite form, and until the other participating organizations shall have taken such action as may be necessary to their active participation in the scheme proposed.

3. That it is suggested that the purposes of the proposed American Engineering Standards Committee may best be developed under the auspices of the recently organized Engineering Council, and it is recommended that the Organization Committee get into communication with that body with a view of developing means whereby the purposes of the proposed American Engineering Standards Committee may become one of the functions of the Engineering Council.

On motion these recommendations were adopted.

It was further decided to continue the present three representatives of the American Society for Testing Materials on the Organization Committee of the proposed American Engineering Standards Committee.

A letter under date of December 29, from Mr. Alfred D. Flinn, Secretary United Engineering Society, Engineering Foundation and Engineering Council, expressing the hope of closer future cooperation between the three bodies named and the American Society for Testing Materials, and proffering his help in that connection, was read, as well as the reply thereto by the Secretary-Treasurer.

The sub-committee of three, consisting of Past-Presidents Gibbs, Stevenson and the Secretary-Treasurer, which had been appointed to act in an advisory capacity to the Executive Committee in the matter of the following resolution adopted at the last annual meeting,

Resolved, That it is the sense of the members present at this annual meeting that the Executive Committee be requested to give consideration to the general subject of the formation of and methods of procedure to be followed by joint committees and the publication of joint reports; whether these joint committees be made up from various committees of this Society or of representatives of this Society and other societies and organizations. ,

presented a report. Voted to approve the report, and to refer the recommendations therein affecting the Regulations Governing Standing Committees to Committee E-5 for consideration, with the request that that committee prepare regulations, and submit the same to the Executive Committee at its next quarterly meeting, covering cooperation between the various A.S.T.M. committees and this publication of their reports.

The request of Committee C-2 on Reinforced Concrete that the Executive Committee invite the A.S.C.E., A.R.E.A., Amer. Concrete Inst., and the Portland Cement Assoc. to appoint committees to cooperate in the preparation of specifications for Reinforced Concrete, which had been laid on the table at the last meeting of the Executive Committee pending the report of the sub-committee of three referred to above, was again laid on the table pending the action of Committee E-5 on matters in the report of the sub-committee affecting the Regulations Governing Standing Committees.

REGULAR MEETING, April 9, 1918.—Engineers' Club, Philadelphia. Present: Past-Presidents, A. W. Gibbs, A. A. Stevenson. Members of Executive Committee, W. H. Bassett, John Brunner, J. A. Capp, W. M. Kinney. Secretary-Treasurer, Edgar Marburg.

Past-President Stevenson presided.

The Secretary-Treasurer reported that favorable action had been taken on 86 new applications for membership; 49 members had resigned; 63 members had been dropped for non-payment of 1917 dues; and the Society has had a loss of 5 members by death, making the total membership in the Society on April 1, 1918, 2179.

Recent correspondence between the Hon. W. G. McAdoo, Director-General of Railroads, and President Bixby was submitted, in re the status of the railroads in relation to the Society in so far as the payment of dues and any other future financial relations are concerned, which may be briefly summarized in the statement that the present conditions in this respect may be continued pending a more explicit official statement on the part of the Director-General, which may be expected on or before April 30, 1918.

The appointment of Mr. Albert Ladd Colby as the representative of the Society at an International Conference in London, which had been referred with power at the last meeting of the Executive Committee to a sub-committee consisting of Past-Presidents Stevenson and Merriman, Mr. W. H. Bassett and the Secretary-Treasurer, was reported by the last-named, as well as certain special circumstances surrounding this appointment, and the fact that information has been received of the expected return of Mr. Colby towards the end of April.

The Secretary-Treasurer reported that the questionnaire intended for members in military services, adopted at the last quarterly meeting, had been slightly amended at the suggestion of the President and had been thus mailed to every member of the Society. The returns show that 114 members of the Society are in active military service.

The Secretary-Treasurer made a brief informal report on the results to date from the cooperative efforts of the Society on behalf of the Bureau of Ordnance in "Recruiting Men for Trench Warfare Section," as announced in Circular to Members No. 128, issued in February last at the invitation of the Ordnance Department.

The report of the Nominating Committee for Officers for the ensuing year was reported in substance as follows with the statement that a formal acceptance of the nomination had been received from each nominee:

For President: G. H. Clamer.
For Vice-President: George S. Webster.
For Members of Executive Committee: G. Aertsen, G. K. Burgess, G. B. Heckel and K. W. Zimmerschied.

The Secretary-Treasurer reported the appointment of Mr. J. A. Capp in place of Mr. C. D. Young resigned, on the conference committee in relation to the A.S.M.E. Boiler Code, the A.S.T.M. representatives on that committee consisting thus of Mr. J. A. Capp, Mr. F. J. Cole and Mr. C. F. W. Rys.

The Secretary-Treasurer reported that by authorization of President Bixby, Committees C-3 on Brick and D-4 on Road Materials had appointed there members each for a joint conference to consider the investigation and revision of the present Rattler test and other standard tests for paving brick, and to communicate its findings in due course to the Executive Committee.

The Secretary-Treasurer reported that according to a recent letter from the Secretary of the A.S.M.E., the Council of that Society was expected to take action on the 19th inst. on the proposed transfer of the work of Committee E-3 on Revision of Pipe Threads to the A.S.M.E., on which Committee E-3 had previously taken favorable action.

The following recommendations submitted on behalf of Committee E-5 on Standing Committees were on motion approved:

1. To publish the book of A.S.T.M. Standards triennially beginning with the 1918 edition with the understanding, (*a*) that it be brought to the notice of the Society, as provided in the by-laws, in so far as the amendment of the latter may be involved, and (*b*) that suitable changes be made in the Regulations Governing Standing Committees, the latter being shown in the following in which the words in italics are new and the words in brackets are to be omitted:

17. Procedure Governing the Adoption of Standards.—Any recommendations affecting standards presented by the appropriate committees at the annual meeting of the Society shall be subject to the following provisions in Article VI, *Section 1*, of the by-laws:

[The term "Standards" shall be applied collectively to standard specifications, standard tests, standard methods, and standard definitions.]

"Proposed new standards [or proposed amendments of existing standards] shall be presented at [the] *an* annual meeting, *at which they may be amended* [At this meeting amendments may be made] by a two-thirds vote of those voting. [The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on] *On* two-thirds vote of those voting, *they shall be printed, as presented or as amended,* in the Proceedings [under a section designated] *and separately under the title* "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. [If introduced in an even year such tentative standards shall be published for two years, and if introduced in an odd year they shall be published for one year.] At the *next* annual meeting [in the next even year following their introduction, such] tentative standards shall be subject to amendment by a two-thirds vote of those voting. [and to reference] *They may then be referred*, by a like vote, to letter ballot of the Society, *in which case a* [A] two-thirds vote of those voting shall be required for adoption; *or, on the recommendation of the committee concerned, they may be continued as tentative, as printed or as amended, in which case the above prescribed procedures shall apply at any succeeding annual meeting.*

"*Proposed amendments of existing standards shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting. On two-thirds vote of those voting they shall be printed, as presented or as amended, in the Proceedings as part of the report of the appropriate committee; and collectively under the same cover with the Tentative Standards for that year. At any succeeding annual meeting they shall be subject to amendment by a two-thirds vote of those voting; and at the annual meeting in the year in which the book of A.S.T.M. Standards will next be published, they shall be subject to reference by a like vote to letter ballot of the Society, in which case a two-thirds vote of those voting shall be required for adoption.*

"The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or [two] *more* years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected."

"[The term 'Recommended Practice' shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer.] The above requirements governing action on *proposed* new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice."

2. That the present section on "Cooperation with Other Committees," in the Regulations Governing Standing Committees, be changed to the following form as to (*a*) headings, (*b*) the omission of the words in brackets, and (*c*) the insertion of the words in italics:

V. COOPERATION WITH COMMITTEES OF OTHER BODIES.

19. Methods of Initiating Cooperation.—[A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.] A standing committee desiring to *cooperate with committees of other bodies on like or cognate subjects, or to* bring about the appointment of similar committees by other [societies] *bodies* for purposes of cooperation, shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the desired end shall be conducted [on behalf of the Executive Committee] by the Secretary-Treasurer of the Society. *Such cooperative relations shall entail no conditions at variance with these regulations, and shall impose no restrictions upon the free and independent action of the standing committee.*

Committee E-5 further recommended that the following proposed "Regulations Governing Cooperative Relations":

20. Regulations Governing Cooperative Relations.—*A committee which may have been brought into cooperative relations with committees of other bodies as provided in Section 19, will be regarded as constituting with these other committees, a "Joint Committee." The participation of an A.S.T.M. committee in the work of a joint committee shall be subject to the following conditions:*

(*a*) *That the report of a joint committee shall not be published by any of the several bodies represented on the joint committee without the previous approval of the governing board of every body thus represented, except as to the publication of preprints of such reports for purposes of discussion at meetings of the participating bodies. Such preprints shall bear the following statement:*

PREPRINT.—*This preprint is subject to correction, and is not to be republished wholly or in part pending its formal release by the chairman (give here the name and address of the chairman of the joint committee) of the Joint Committee on (give here the name of the joint committee).*

(*b*) *That permission for the publication of a report of a joint committee by any of the several bodies represented on the joint committee, except in so far as indicated in Paragraph (a), shall, in general, be neither asked nor granted until opportunity has been had for the discussion of the*

report at the next regular general meeting of each of the several participating bodies.

(*c*) *That a joint committee shall not be empowered to terminate its own existence or to consider itself discharged except (1) at the joint initiative and by common agreement of the governing boards of the bodies represented on the joint committee, or (2) at the initial recommendation by the governing board of every body represented.*

In connection with the activities of a joint committee, and especially in the preliminary discussion of a proposed report of such a committee, the A.S.T.M. representatives shall endeavor to keep in touch with the officers of other A.S.T.M. committees whose interests may be affected by the work of the joint committee. In general such intra-society relations shall be left to the discretion of Committee E-5 on Standing Committees, which shall be empowered to act either at its own initiative or upon the recommendation of the particular committee which primarily represents the Society on the joint committee.

submitted to Committee E-5 by the Executive Committee, in connection with the report at the January meeting of the sub-committee appointed to consider a certain resolution presented at the last annual meeting, be approved with the following amendments, which have been embodied in the paragraphs quoted:

(*a*) Substitute for the word "society", wherever it appears, the word "body";

(*b*) In paragraph (*b*) change the words in the next to the last line "at a general meeting" to read "at the next regular general meeting,"

It was voted to defer action on this recommendation pending further developments in certain matters.

It was agreed that the request on behalf of Committee C-2 on Reinforced Concrete, that the A.S.C.E., A.R.E.A., A.C.I. and Port. Cement Assoc. be invited to appoint committees to cooperate with Committee C-2 in preparing specifications for reinforced concrete, which had been laid on the table at the last meeting, pending the report of Committee E-5, could not, consistently with the above action, be taken up now.

The report of Committee E-5 on the request of the Executive Committee that it give consideration to "Recommendations covering proposed regulations governing cooperation between the various A.S.T.M. committees in matters of common (overlapping) interests, including the publication of reports thereon," to the effect that in the judgment of Committee E-5 "such regulations are neither necessary nor desirable, and that no reference to cooperation between A.S.T.M. committees need appear in the Regulations Governing Standing Committees" was approved.

In the matter of the translation under Government auspices of selected standard specifications of the Society, the Secretary-Treasurer presented a letter under date of April 8 from Mr. C. D. Snow, Acting Chief of the Bureau of Foreign and Domestic Commerce, and reported (1) that 99 standards had been translated in Spanish; (2) that 1 standard, namely, Standard Specifications and Tests for Portland Cement, was ready for press; and (3) that 21 other specifications were being finally edited ready to be put in type.

It was decided to authorize the Secretary-Treasurer:

1. To notify Mr. Snow by wire that the action of the Executive Committee regarding his letter is favorable;
2. To indicate that the Executive Committee accepts the proposals in his letter with the understanding:
   (*a*) That reference will be made to the copyright in English of every A.S.T.M. specification translated, except the Standard Specifications and Tests for Portland Cement;
   (*b*) That in thus accepting Mr. Snow's suggestion in relation to the latter specifications, the Executive Committee does not thereby waive any rights in the matter to which the Society may be legally entitled.
3. To advise Mr. Snow that the prices covering the distribution of the translated A.S.T.M. Standards will be left entirely to the U. S. Department of Commerce in accordance with existing legal requirements.

ADJOURNED MEETING, June 1, 1918.—United Engineering Building, New York City. Present: Past-Presidents, A. W. Gibbs, A. A. Stevenson; Members of Executive Committee, W. H. Bassett, J. A. Capp, W. F. M. Goss, W. M. Kinney, G. W. Thompson, C. D. Young (represented by proxy by G. Aertsen); Assistant to the Secretary, C. L. Warwick.

Mr. W. F. M. Goss presided.

Past-President A. A. Stevenson announced that the Secretary-Treasurer, Mr. Edgar Marburg, was seriously ill and had been obliged to be away from his duties since May 25.

It was explained that the absence of the Secretary-Treasurer necessitated certain action on the part of the Executive Committee in order that the business of the Society may be carried on without interruption.

Voted that Past-Presidents A. W. Gibbs and A. A. Stevenson be appointed a special committee to draft the necessary amendments in the by-laws to give the Executive Committee power, when in its judgment it is desirable, to appoint an Assistant Secretary and an Assistant Treasurer, whose duties shall be fixed by the Executive Committee, such amendments to be offered at the annual meeting for immediate adoption.

REPORT OF COMMITTEE A-1

ON

STEEL.

During the past year Committee A-1 has held one meeting, at which the recommendations which follow were considered and duly referred to letter ballot vote of the committee.

Recommendations.—The recommendations of the committee affecting standards and tentative standards are presented first in summarized form for convenient oversight. They are then referred to where necessary in greater detail, being grouped for convenience in the order of the respective sub-committees directly responsible for them.

I. Proposed Revisions in Standards.

The committee recommends that the revisions in the following standards Nos. 1 to 12, inclusive, given in Appendix I to this report, be referred to letter ballot of the Society for adoption as standard. The revisions are divided into two groups:

A.—Revisions proposed at the last annual meeting and now recommended for adoption by letter ballot, either as presented last year, or in slightly amended or supplemented form as indicated in Appendix I to this report; and

B.—Revisions proposed for the first time, which the committee recommends be referred to letter ballot of the Society by the necessary nine-tenths vote of the annual meeting.

The standard specifications in each group are as follows:

Group A.

Revisions Recommended for Adoption as presented in 1917,[1] without Amendment:

1. For Carbon-Steel and Alloy-Steel Forgings (A 18–16).
2. For Carbon-Steel Car and Tender Axles (A 21–14).

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 97 ff. (1917).

3. For Welded Steel and Wrought-Iron Pipe (A 53–15).

As explained later under the heading "Steel Tubes and Pipes," the committee has eliminated those sections in the present specifications relating exclusively to wrought iron and embodied the revisions proposed last year, and now appends the specifications in their proposed revised form under the title "Standard Specifications for Welded Steel Pipe."[1]

4. For Boiler and Firebox Steel for Locomotives (A 30–16).

Revisions Recommended for Adoption as presented in 1917,[2] Amended or Supplemented as Indicated in Appendix I:

5. For Quenched-and-Tempered Carbon-Steel Axles, Shafts, etc. (A 19–16).
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts, etc. (A 63–16).
7. For Lap-Welded and Seamless Steel Boiler Tubes, etc., for Locomotives (A 28–16).

The revisions proposed in these specifications last year, which are amended and supplemented as indicated in Appendix I to this report, are extensive, and in the interest of convenience the specifications are appended in their proposed revised form under the title "Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes for Locomotives."[1, 3]

8. For Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15).

These specifications, owing to the extensive revisions proposed, are also appended in their proposed revised form under their present title.[1, 4]

9. For Automobile Carbon and Alloy Steels (A 29–16).

The revisions proposed last year in specifications Nos. 1, 2, 4, 5, 6, and 9 above are comparatively brief and it is not

[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 97 ff. (1917).
[3] For further revisions in these specifications, see p. 129.—ED.
[4] For further revisions in these specifications, see pp. 129–131.—ED.

necessary to reprint the entire proposed revised specifications, as has been done for specifications Nos. 3, 7 and 8. The proposed revisions are, however, repeated in Appendix I for convenient reference.

GROUP B.

Revisions Proposed for First Time, and Recommended for Adoption:

10. For Structural Steel for Cars (A 11–16).

The revisions in these specifications recommended in Appendix I are designed to provide requirements for plates for forge welding, as explained more fully under the heading "Structural Steel for Cars."[1]

11. For Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17–13).

In its report last year,[2] the committee proposed certain revisions in these specifications, relating exclusively to the chemical requirements of carbon and alloy-steel billets, and stated that the necessary revisions in form and wording would be presented at this meeting. While these revisions have been embodied without amendment in the proposed revised Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings appended to this report, two other important revisions—namely, those relating to classification by segregation and to chipping, which are referred to in more detail under the heading "Steel Billets and Forgings"—are also included and presented for the first time. The committee accordingly requests the approval of the meeting to include these new requirements in the proposed revised specifications recommended for adoption this year.

12. For Steel Tires (A 26–16).

As explained under the heading "Steel Tires," the revision in these specifications proposed in Appendix I is designed to correct an omission.

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[1] The proposed revisions in these specifications were withdrawn when this report was presented at the annual meeting. See Summary of Proceedings, p. 17.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 97 (1917).

II. TENTATIVE STANDARDS RECOMMENDED FOR ADOPTION AS STANDARD.

The committee recommends that the following four tentative specifications published last year among the Tentative Standards of the Society[1] be referred without amendment to letter ballot of the Society for adoption as standard:

13. For Steel Track Spikes (A 65–16 T).
14. For Steel Screw Spikes (A 66–16 T).
15. For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T).
16. For Elliptical Springs for Automobiles (A 69–16 T).

III. PROPOSED REVISIONS IN TENTATIVE STANDARDS.

The committee recommends that the following tentative specifications be revised as explained later under the heading "Steel Rails and Accessories," and continued as tentative:

17. For Steel Tie Plates (A 67–17 T).

The specifications are appended to this report in their proposed revised form.[2]

The above recommendations have been referred to letter ballot of the committee, which consists of 109 members; 96 ballots have been cast, 13 members having refrained from voting. The analysis of the vote of the committee is given in the accompanying table.

Specifications to be Continued as Tentative.—The committee further recommends that the two remaining tentative specifications for which it is responsible, namely, Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T)[3] and Tentative Specifications for Carbon Tool Steel (A 71–17 T), be continued as tentative without amendment, since the committee is not yet prepared to recommend them as standard.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 537–540 and 546–556 (1917).

[2] See p. 445.

[3] Revisions in these specifications were proposed when this report was presented at the annual meeting. See pp. 131–132.—ED.

ANALYSIS OF VOTE OF COMMITTEE A-1 ON ITS RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS.

Items.	Affirmative	Negative.	Not Voting.[a]
I. PROPOSED REVISIONS IN STANDARDS.			
1. For Carbon-Steel and Alloy-Steel Forgings (A 18-16)	74	3	19
2. For Carbon-Steel Car and Tender Axles (A 21-14)	61	3	32
3. For Welded Steel and Wrought-Iron Pipe (A 53-15)	54	0	42
4. For Boiler and Firebox Steel for Locomotives (A 30-16)	62	1	33
5. For Quenched-and-Tempered Carbon-Steel Axles, etc. (A 19-16)	64	2	30
6. For Quenched-and-Tempered Alloy-Steel Axles, etc. (A 63-16)	66	2	28
7. For Steel Boiler Tubes, etc., for Locomotives (A 28-16)	53	0	43
8. For Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52-15)	55	0	41
9. For Automobile Carbon and Alloy Steels (A 29-16)	63	0	33
10. For Structural Steel for Cars (A 11-16)	68	1	27
11. For Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17-13)	48	27	21
12. For Steel Tires (A 26-16)	57	3	36
II. TENTATIVE STANDARDS RECOMMENDED FOR ADOPTION AS STANDARD.			
13. For Steel Track Spikes (A 65-16 T)	55	0	41
14. For Steel Screw Spikes (A 66-16 T)	52	1	43
15. For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68-16 T)	58	3	35
16. For Elliptical Steel Springs for Automobiles (A 69-16 T)	51	1	44
III. PROPOSED REVISED TENTATIVE STANDARD.			
17. For Steel Tie Plates (A 67-17 T)	53	2	41

Total number of ballots cast	96
Number of members who failed to vote	13
Total membership	109

[a] In this column is recorded the number of votes cast as "not voting" on the various items.

In the following, the committee presents the foregoing recommendations in greater detail where necessary, as well as other features of its work, grouped for convenience in the order of the respective sub-committees responsible for them.

STEEL RAILS AND ACCESSORIES (SUB-COMMITTEE I).

Two tentative specifications, published in the Proceedings[1] last year, are recommended for adoption as standard without

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 537–540 (1917).

revision, namely: Tentative Specifications for Steel Track Spikes (A 65–16 T), and Tentative Specifications for Steel Screw Spikes (A 66–16 T).

Specifications for Tie Plates.—The Tentative Specifications for Steel Tie Plates (A 67–17 T), published in the Proceedings[1] last year, have been revised by dividing the specifications into plates of Soft and Medium grade, for each of which minimum carbon limits for Bessemer and open-hearth steel are specified. All requirements as to tension tests have been omitted, and appropriate bend test requirements for each grade substituted. The specifications are appended to this report in their proposed revised form,[2] and the committee recommends that they be printed as tentative for one year.

Report on Rail Situation.—A report on the progress during the past year in various phases of the rail situation is presented herewith as Appendix II to this report.

Specifications for Girder Rails.—The committee has under consideration, in cooperation with a committee of the American Electric Railway Engineering Association, the question of omitting the drop-test in the Standard Specifications for Open-hearth Steel Girder and High Tee Rails (A 2–12) and the substitution therefor of a Brinell hardness test.

STRUCTURAL STEEL FOR CARS (SUB-COMMITTEE II).

At the request of the Tank Car Committee of the Master Car Builders' Association and other interested consumers, the committee has given careful consideration to specifications for plates for welding. The question was referred to Sub-Committee II, which held two meetings at which specifications now in use by welding companies were presented for consideration and discussion. In pursuance of the report of this sub-committee, the committee recommends that requirements for "plates for forge welding" be incorporated in the Standard Specifications for Structural Steel for Cars (A 11–16), as indicated in Appendix I, and referred to letter ballot for adoption as standard.

This recommendation is made in pursuance of action taken at the January meeting of the committee, at which the chairman

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 541 (1917).

[2] See p. 445.—ED.

was directed to call attention to the fact that the proposed requirements are recommended for adoption this year to meet the needs of consuming interests. Since the meeting, however, it has developed that these requirements are not entirely satisfactory to the welding companies which use these plates. The matter will accordingly be reconsidered by Sub-Committee II, which will report to the committee at its June meeting.[1]

SPRING STEEL AND STEEL SPRINGS (SUB-COMMITTEE IV).

Two tentative specifications, published in the Proceedings[2] last year, are recommended for adoption as standard without revision, namely: Tentative Specifications for Carbon-Steel Bars for Railway Springs with Special Silicon Requirements (A 68–16 T), and Tentative Specifications for Elliptical Springs for Automobiles (A 69–16 T).

STEEL BILLETS AND FORGINGS (SUB-COMMITTEE VI).

Revisions in Standard Specifications.—Last year the committee proposed revisions in the following four standard specifications, with the understanding that they would be subject to adoption as standard this year:

For Carbon-Steel and Alloy-Steel Forgings (A 18–16);
For Quenched-and-Tempered Carbon Steel Axles, Shafts, etc. (A 19–16);
For Quenched-and-Tempered Alloy-Steel Axles, Shafts, etc. (A 63–16);
For Carbon-Steel Car and Tender Axles (A 21–14).

These revisions are repeated for convenience in Appendix I. One additional minor revision is proposed in Specifications A 19 and A 63, as indicated in Appendix I, designed to leave the rough-turning of forgings before quenching to the option of the manufacturer.

The committee recommends that these revisions be referred to letter ballot for adoption as standard.

Proposed Revised Specifications for Billets.—Last year the committee presented certain proposed revisions in the Standard

[1] The proposed revisions in these specifications were withdrawn when this report was presented at the annual meeting. See Summary of Proceedings, p. 17.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 546–556 (1917).

Specifications for Blooms, Billets and Slabs for Carbon-Steel Forgings (A 17–13), covering chemical requirements for alloy-steel billets and revising the carbon and manganese requirements for carbon-steel billets,[1] with the understanding that they would be subject to adoption as standard this year. These revisions have been embodied in the proposed Revised Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings appended to this report.[2] Other changes of minor importance have been made, namely: the omission in Section 2, which states the material covered by the specifications, of the purposes for which the various types and grades are frequently used, the number of types and grades making it impracticable to follow the present specifications[3] in this regard; the omission of the footnote to Section 6 of the present specifications; and a slight rearrangement of certain sections.

Two important proposed new revisions, however, have also been incorporated in the appended specifications. These comprise:

1. The division of the specifications into two classes, defined in Section 2 (*c*) of the specifications, differing in the methods of sampling for chemical analysis and in chemical requirements. The distinctive features of each class are embodied in the requirements for check analyses by the purchaser, Section 9 of the appended specifications.[2] The requirements as to check analyses in the present specifications and the proposed new requirements are given below:

Present Section on "Check Analyses:"[4]

"8. (*a*) An analysis may be made by the purchaser from at least one billet representing each melt. The chemical composition thus determined shall conform to the requirements specified in Section 6. Drillings for analysis shall be taken from the billet with a $\frac{5}{8}$-in. drill, parallel to the axis of the ingot as cast, at any point midway between the center and surface.

"(*b*) In addition to the complete analysis specified in Paragraph (*a*), a carbon determination may be made by

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 97–99 (1917).

[2] These specifications are not reprinted here but appear in the 1918 Book of A.S.T.M. Standards.—ED.

[3] 1916 Book of A.S.T.M. Standards, p. 138.

[4] *Ibid.*, p. 139.

the purchaser of drillings taken from the center of the billet with a $\frac{5}{8}$-in. drill, parallel to the axis of the ingot as cast, to determine by the variation in carbon the amount of segregation."

Proposed New Section on "Check Analyses:"

"9. (*a*) *Class I.*—For billets of Class I, an analysis may be made by the purchaser from one billet representing each melt. The chemical composition thus determined shall conform to the requirements specified in Section 7. Drillings for analysis shall be taken with a $\frac{5}{8}$-in. drill, parallel to the axis of the ingot as cast, at any point midway between the center and surface of the billet.

"(*b*) *Class II.*—For billets of Class II, the purchaser or his representative may select one top-cut billet from which to make check analyses to represent each melt. Two sets of drillings shall be taken from the top face of this billet at points on the same diagonal of the billet. The drillings shall be taken with a $\frac{5}{8}$-in. drill parallel to the axis of the ingot as cast. The distance from the center of the billet to the drilling points shall be respectively 15 and 80 per cent of the length of the half diagonal of the billet.

"(*c*) From the drillings taken at the 80-per-cent point a complete analysis may be made. The chemical composition thus determined shall conform to the requirements specified in Section 7.

"(*d*) From the drillings taken at the 15-per-cent point a carbon determination may be made. The difference between the carbon content of the drillings from the 15-per-cent point and that of the drillings from the 80-per-cent point, expressed as a percentage of the latter, shall not exceed the following values:

(1) For billets 15 in. or under in thickness, 15 per cent;
(2) For billets over 15 in. in thickness, 20 per cent.

"(*e*) If in any melt the drillings taken in accordance with Paragraph (*b*) do not conform to the requirements of Paragraph (*d*), additional drillings may be taken in a similar manner after making a further top discard from the material from each ingot of at least 10 per cent of the original ingot weight. The results of this analysis shall conform to the requirements of Paragraph (*d*); otherwise, the melt represented shall be rejected."

2. The revision of the requirements as to chipping to remove surface defects. The present and proposed new requirements are given below:

Present Section on "Chipping:"[1]

> "9. The billets may be chipped to a depth not over $\frac{1}{2}$ in., unless otherwise specified. Chipping shall be done in such a manner as not to cause laps when the billets are properly forged."

Proposed New Section on "Chipping:"

> "10. (*a*) Billets may be chipped to remove surface defects, provided that the depth of chipping does not exceed $\frac{1}{16}$ in. for each inch of dimension concerned, up to a maximum depth of $\frac{3}{4}$ in., and provided that the width of the chipping is at least four times its greatest depth; except that in the case of slabs where the width is at least twice the thickness, the depth of chipping on the wide surfaces may exceed this allowance by 50 per cent, up to a maximum depth of $\frac{3}{4}$ in.
>
> "(*b*) In special cases, particularly large alloy-steel billets where it is necessary and is not injurious, greater depth of chipping may be permitted by special agreement between the manufacturer and the purchaser."

Although these two revisions are proposed here for the first time, the committee feels that it is desirable to incorporate them in the proposed revised specifications this year, if they meet with the approval of the meeting. The committee accordingly recommends that the proposed revised specifications, as appended to this report, be referred to letter ballot for adoption as standard.

The above recommendation is made in pursuance of action taken by the committee at its January meeting. While this action has been approved by majority vote of those voting by letter ballot, considerable opposition to the specifications in their proposed revised form has developed in the committee, as evidenced by the result of the vote: affirmative, 48; negative, 27; not voting, 21. The committee will accordingly reconsider this part of its report at its June meeting, with a view of presenting, if possible, a substantially unanimous recommendation concerning these specifications.

[1] 1916 Book of A.S.T.M. Standards, p. 139.

STEEL TIRES (SUB-COMMITTEE VII).

The recommendation in Appendix I that the usual section on discard from ingot be inserted in the Standard Specifications for Steel Tires (A 26–16) is designed to correct an inadvertent omission in these specifications. The committee recommends that this revision be referred to letter ballot; and, in view of the fact that it is simply a correction, further recommends that, if adopted, the revised specifications be published without changing the year of last revision (1916) in the serial designation.

STEEL TUBES AND PIPES (SUB-COMMITTEE IX).

Specifications for Locomotive Boiler Tubes (A 28–16).—At the last annual meeting the committee proposed certain revisions in the Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes, etc., for Locomotives (A 28–16).[1] In Appendix I to this report certain amendments of these revisions are given, as well as revisions in the sections on Hydrostatic Tests, Number of Tests, Finish, and Marking designed to harmonize these specifications with the Standard Specifications for Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15) in their proposed revised form.

For convenient reference, Specifications A 28, as revised, are appended hereto[2] under their proposed new title "Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes," and the committee recommends that they be referred to letter ballot for adoption as standard.

Specifications for Boiler Tubes for Stationary Service (A 52–15).—Last year the committee proposed extensive revisions in the Standard Specifications for Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15).[3] In Appendix I an amendment to these revisions is given, as well as two other minor revisions. The committee recommends that the specifications, in their proposed revised form as appended hereto,[4] be referred to letter ballot for adoption as standard.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 101–103 (1917).

[2] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards. For further revisions in these specifications, see p. 129.—ED.

[3] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 103–108 (1917).

[4] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards. For further revisions, see pp. 129–131.—ED.

As announced in its report last year, it is intended to append to these specifications, as a matter of information, the Table of Minimum Thicknesses of Boiler Tubes for Various Diameters and Working Pressures in its latest revised form as approved by the Boiler Code Committee of the American Society of Mechanical Engineers.

Specifications for Welded Pipe (A 53–15).—The committee recommended certain revisions in the Standard Specifications for Welded Steel and Wrought-Iron Pipe (A 53–15) at the last annual meeting.[1] At that meeting Committee A-2 on Wrought Iron, which has acted jointly with Committee A-1 in revising these specifications, presented Tentative Specifications for Welded Wrought-Iron Pipe[2] consisting of those sections of Specifications A 53 applicable to wrought-iron pipe. Committee A-1 has therefore eliminated those requirements of the specifications relating exclusively to wrought iron, and appends hereto[3] proposed revised Standard Specifications for Welded Steel Pipe, with the recommendation that they be referred to letter ballot for adoption as standard.

AUTOMOBILE STEELS (SUB-COMMITTEE X).

At the last annual meeting the committee proposed a revision in the Standard Specifications for Automobile Carbon and Alloy Steels (A 29–16), which for convenience is repeated in Appendix I. In pursuance of a suggestion made during the discussion of this revision on the floor of the meeting, the committee recommends that the revision be amended by the addition of the footnote indicated in Appendix I, and referred to letter ballot for adoption as standard.

BOILER STEEL (SUB-COMMITTEE XI).

Specifications for Boiler and Firebox Steel for Locomotives (A 30–16).—The committee recommends that the revisions proposed last year in the Standard Specifications for Boiler and Firebox Steel for Locomotives (A 30–16), which for convenience are repeated in Appendix I, be referred to letter ballot for adoption as standard.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 108–109 (1917).

[2] *Ibid.*, p. 568.

[3] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.

Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T).—The committee is cooperating with the Boiler Code Committee of the American Society of Mechanical Engineers, through the A.S.T.M. representatives on a joint conference committee, in the matter of revising the Tentative Specifications for Boiler and Firebox Steel[1] to differentiate more sharply between the boiler and firebox grades. At the meeting of the committee it was voted to recommend that the specifications be continued as tentative; and Sub-Committee XI on Boiler Steel was directed to consider certain recommendations of the Boiler Code Committee and to report their recommendations at the June meeting of the committee.[2]

METHODS OF CHEMICAL ANALYSIS (SUB-COMMITTEE XII).

It is expected that the report of Sub-Committee XII will be submitted to the committee at its June meeting, and presented to the Society as an Addendum to this report.[3]

TOOL STEEL (SUB-COMMITTEE XIV).

The committee is not prepared to recommend that the Tentative Specifications for Carbon Tool Steel (A 71–17 T)[4] be adopted as standard, and asks that they be continued as tentative for another year.

BEND TEST REQUIREMENTS (SPECIAL SUB-COMMITTEE).

The committee can only report progress in its investigation of the bend test requirements in the various steel specifications. A comprehensive series of tests is well under way, but has been delayed beyond expectation by the pressure of war orders in the steel mills.

CAST STEEL CHAIN.

Since the meeting of the committee in January its scope has been widened to cover the subject of Cast Steel Chain. The demand for anchor chain in connection with the work of the

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 557 (1917).

[2] Revisions in these specifications were proposed when this report was presented at the annual meeting. See pp. 131–132.—ED.

[3] The report of this sub-committee was presented by title at the annual meeting and accepted for publication in the Proceedings. It was not found possible, however, to prepare the report for publication this year, and it will accordingly be presented by Committee A-1 next year.—ED.

[4] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 562 (1917).

Emergency Fleet Corporation has been so great that as early as last October the Engineering Committee of the Council of National Defense gave careful consideration to the subject and appointed a committee to conduct investigations and tests. Since that time numerous tests have been made on anchor chain. The General Electric Co. and the National Malleable Castings Co. have undertaken extensive tests of electric cast steel anchor chain, which were witnessed by members of the above-mentioned committee, as well as representatives of interested Government and other Bureaus, such as the U. S. Navy Department, U. S. Steamboat Inspection Service, American Bureau of Shipping and Lloyd's Register of Shipping.

The results of these tests were such that it was thought desirable to give immediate consideration to the preparation of specifications for electric cast steel anchor chain. It was suggested that this could be done most expeditiously under the auspices of Committee A-1, where opportunity would be afforded for representation of the producing and consuming interests; and this suggestion meeting with general approval, the chairman of the committee called a meeting of all representative interests for the purpose of presenting and discussing the test results and of organizing a sub-committee to draw up specifications. This meeting was held in New York City on March 16, and the sub-committee was formally organized as Sub-Committee XVI on Cast Steel Chain, under the chairmanship of Mr. F. M. Waring, Vice-Chairman of Committee A-1.

The sub-committee is expected to devote itself primarily to an intensive study of the anchor chain problem, in relation to which it is hoped that the Society will thus find it possible to render valuable aid to the Government. The sub-committee now (April) has under consideration proposed Specifications for Electric Cast Steel Anchor Chain, and is conducting investigations and tests of samples of anchor chain to determine suitable drop-test requirements to be included in the specifications. It is expected that the sub-committee will present these specifications to the committee at its June meeting, and that the committee will make suitable recommendations concerning them to the Society on the floor of the annual meeting.[1]

[1] For report of this sub-committee, see pp. 133–134.—ED.

USE OF A.S.T.M. STEEL SPECIFICATIONS UNDER PRESENT INDUSTRIAL CONDITIONS.

Committee A-1 at its meeting in January discussed the unusual conditions obtaining in manufacturing industries in general, and particularly in the steel industry. Attention was called to the fact that in many cases purchasers had allowed temporary modifications of standard specifications, thereby permitting the shipment of material that ordinarily would not fall within the limits of the specifications as to chemical or physical properties. The committee was of the opinion that this temporary adjustment of the standard specifications to meet unusual industrial conditions offered an excellent opportunity to study the effects of such departures from standards upon the performance of the material in service, and to collect all of the data available from such study so that the results may be before the committee for use when considering revisions in existing standards. With this in mind, the committee directed its sub-committees to compile, in so far as possible, an adequate record of the service of material purchased under any of the committee's specifications which may be thus modified by special agreement.

The following resolution was also adopted and it is the hope of the committee that purchasers and producers generally will cooperate by making available to the committee all data which may be accumulated:

> "Committee A-1 on Steel recognizes the difficulty now existing under the stress of war conditions in securing an adequate supply of material under the standard specifications for steel adopted by the Society. It has been considered more desirable, however, for variations from these specifications to be arranged between the manufacturer and the purchaser as applying to individual cases, than for the Society to make general changes in the specifications under the present unsettled conditions. An adequate record should be kept of the service rendered by material purchased under such arrangements, in order that the data may be available when revisions of the specifications are under consideration later."[1]

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[1] After subsequent consideration of this entire question, Committee A-1 recommended that a note be added to certain specifications raising phosphorus and sulfur requirements 0.01 per cent. For details of action taken, see Summary of Proceedings, pp. 19–22.—ED.

This report has been submitted to letter ballot of the committee, which consists of 109 members, of whom 79 have voted affirmatively, 1 negatively, and 29 have refrained from voting.

Respectfully submitted on behalf of the committee,

J. A. CAPP,
Chairman.

C. L. WARWICK,
Secretary.

EDITORIAL NOTE.

For Addendum to this report, see page 128.
For Discussion, see page 136.

APPENDIX I.

PROPOSED REVISIONS IN SPECIFICATIONS FOR STEEL AND STEEL PRODUCTS.

In this appendix are given proposed revisions in certain standard specifications, which are numbered from 1 to 12 to correspond with the report of the committee.[1] After the title of each specification is given its serial designation and page number in the 1916 Book of A.S.T.M. Standards, where it appears in its present form. The revisions proposed in 1917 appear in *Proceedings*, Vol. XVII, Part I, pages 97–110 and 118–120.

No. 1.—Standard Specifications for Carbon-Steel and Alloy-Steel Forgings: A 18–16 (page 141).

Revisions proposed in 1917.

1. *Section 7* (*b*).—Omit the footnote to this section appearing at the bottom of page 143 of the 1916 Book of A.S.T.M. Standards.

2. *Section 13* (*a*).—Strike out the words "in Classes A to I inclusive," making the section read as follows:

> "13. If the results of the physical tests of any test lot of forgings do not conform to the requirements specified, the manufacturer may re-treat such lot one or more times and retests shall be made as specified in Section 12."

3. *Section 13* (*b*).—Omit.

[1] See pp. 100–102.—Ed.

No. 2.—STANDARD SPECIFICATIONS FOR CARBON-STEEL CAR AND TENDER AXLES: A 21–14 (page 173).

Revisions proposed in 1917.

1. Insert the following new Section 1 entitled "Scope," and re-number all of the remaining sections:

> "1. These specifications cover axles up to and including those $6\frac{1}{2}$ in. in diameter at the center. Axles over $6\frac{1}{2}$ in. in diameter at the center shall not be subject to the drop test, but may be purchased under the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (Serial Designation: A 18) of the American Society for Testing Materials."

2. Replace the present Section 5 by the following:

> "6. (*a*) The test axle shall be so placed on supports 3 ft. apart that the tup will strike it midway between the ends. It shall stand without fracture five blows from a tup of 2240 lb. falling from a height H, such that H in feet equals the square of the diameter of the axle at the center in inches, $H=d^2$. The axle shall be turned through 180 deg. after the first and third blows.
>
> "(*b*) The permanent set produced by the first blow shall not exceed that given by the following formulas, in which L = length of axles in inches and d = diameter of axle at center in inches:
>
> For axles over 65 in. in length:
>
> $$\left(\frac{L}{1.9d}-\frac{d}{2}\right)+\tfrac{1}{2}\text{ in.} \qquad (1)$$
>
> For axles 65 in. or under in length:
>
> $$\left(\frac{L}{1.9d}-\frac{d}{2}\right)+1\text{ in.} \qquad (2)$$
>
> "(*c*) The Master Car Builders' Association and the American Railway Master Mechanics' Association have

adopted four standard sizes of axles, the requirements for which, based on the above formula (1), are given in the following table:

Size of Journal, in.	Diameter of Axle at Center, in.	Length of Axle, in.	Height of Drop, ft.	Number of Blows.	Maximum Permanent Set, in.
$4\frac{1}{4}$ by 8	$4\frac{3}{4}$	$84\frac{1}{4}$	$22\frac{1}{2}$	5	$7\frac{1}{2}$
5 by 9	$5\frac{3}{8}$	$86\frac{1}{2}$	29	5	$6\frac{1}{4}$
$5\frac{1}{2}$ by 10	$5\frac{7}{8}$	$88\frac{1}{2}$	$34\frac{1}{2}$	5	$5\frac{1}{2}$
6 by 11	$6\frac{7}{16}$	$90\frac{3}{4}$	$41\frac{1}{2}$	5	$4\frac{3}{4}$

"(*d*) The maximum permanent set is the difference between the distance from a straight edge to the middle point of the axle measured before the first blow and the distance measured in the same manner after the blow. The straight edge shall rest only on the collars or ends of the axle.

"(*e*) The temperature of the test axle shall be between 40 and 120° F."

No. 3.—Standard Specifications for Welded Steel and Wrought-Iron Pipe: A 53–15 (page 215).

Revisions proposed in 1917.

These revisions are not repeated here, as they have been embodied without amendment in the proposed revised Standard Specifications for Welded Steel Pipe appended to this report.[1]

No. 4.—Standard Specifications for Boiler and Firebox Steel for Locomotives: A 30–16 (page 228).

Revisions proposed in 1917.

Section 3.—Omit the copper requirement of "not over 0.05 per cent" for firebox steel.

Also, change the manganese requirement for firebox steel from "0.30–0.50 per cent" to "0.30–0.60 per cent."

[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—Ed.

No. 5.—STANDARD SPECIFICATIONS FOR QUENCHED-AND-TEMPERED CARBON-STEEL AXLES, SHAFTS, AND OTHER FORGINGS FOR LOCOMOTIVES AND CARS: A 19–16 (page 150).

Revisions proposed in 1917.

1. Replace the appendix to these specifications by the following:

"As a guide in deciding on a proof test for quenched-and-tempered forgings, the following particulars regarding three established methods of testing are given.[1] These methods of proof testing are giving satisfactory results in practice.

PROOF TESTS FOR QUENCHED-AND-TEMPERED FORGINGS.

Diameter, in.	PENNSYLVANIA RAILROAD CO.; STANDARD STEEL WORKS CO. Supports 3 ft. Center to Center, Carried on M. C. B. Drop-Test Machine. Height of Drop, ft. and in.		NEW YORK CENTRAL LINES, Rigid Supports 5 ft. Center to Center. CARNEGIE STEEL CO., Rigid Supports at Ends of Forgings.
	1640-lb. Tup.	2240-lb. Tup.	Energy of Blow, ft-lb.
$4\frac{1}{2}$	0 ft. 11 in.	....	700
5	1 " 3 "	....	900
$5\frac{1}{2}$	1 " 8 "	1 ft. 2 in.	1 200
6	2 " 2 "	1 " 7 "	1 700
$6\frac{1}{2}$	2 " 9 "	2 " 0 "	2 500
7	3 " 5 "	2 " 6 "	3 500
$7\frac{1}{2}$	4 " 3 "	3 " 1 "	4 700
8	5 " 1 "	3 " 8 "	6 000
$8\frac{1}{2}$	6 " 2 "	4 " 6 "	7 500
9	7 " 3 "	5 " 3 "	9 000
$9\frac{1}{2}$	8 " 7 "	6 " 3 "	10 000
10	10 " 0 "	7 " 4 "	11 000
$10\frac{1}{2}$	11 " 7 "	8 " 6 "	12 000
11	13 " 5 "	9 " 10 "	13 000
$11\frac{1}{2}$	15 " 3 "	11 " 1 "	14 000
12	17 " 4 "	12 " 8 "	15 000

[1] For more detailed information concerning these methods of proof testing, see Report of Committee A-1 on Standard Specifications for Steel, Appendix IV, "Report on Proof Tests of Finished Forgings," *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 120 (1914); also, Vol. XVII, Part I, p. 115 (1917).

"The Pennsylvania Railroad Co. and the Standard Steel Works Co. require that all axles, shafts and similar forgings shall undergo an impact proof test on an M. C. B. drop-test machine, with supports spaced 3 ft. center to center, two blows being struck with a tup weighing 1640 or 2240 lb. The forging is to have one of the points of support as near as practicable to one end for the first blow and as near as practicable to the other end for the second blow, the forging being turned 90 deg. on its longitudinal axis after the first blow. The requirements as to height of drop given in the accompanying table are derived from the following formulas:

$$\text{For the 1640-lb. tup:}\quad H = 0.01D^3$$
$$\text{For the 2240-lb. tup:}\quad H = 0.0073D^3$$

in which H is height of drop in feet and D is diameter of the forging at the center in inches.

"The New York Central Lines and the Carnegie Steel Co. require that forgings shall be submitted to an impact proof test by having them carried on rigid supports and struck one blow at the center by a tup delivering the number of foot-pounds of energy shown in the accompanying table. The New York Central Lines space the supports 5 ft. center to center, while the Carnegie Steel Co. places the supports as near as practicable to the ends of the forgings."

Revision proposed this year.

2. *Section 5 (a).*—Change the last sentence to read as follows by the omission of the words in brackets:

> "The boring [and rough turning] shall be done before quenching."

NO. 6.—STANDARD SPECIFICATIONS FOR QUENCHED-AND-TEMPERED ALLOY-STEEL AXLES, SHAFTS, AND OTHER FORGINGS FOR LOCOMOTIVES AND CARS: A 63–16 (page 164).

Revisions proposed in 1917.

1. Make the same change as in item No. 1 above of Specifications A 19.

2. *Section 7 (b).*—Omit the footnote to this section appearing at the bottom of page 165 of the 1916 Book of A.S.T.M.

Standards. (Same change as in item No. 1 of Specifications A 18.)

Revision proposed this year.

3. *Section 5 (a).*—Make the same change as in item No. 2 above of Specifications A 19.

No. 7.—Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends and Arch Tubes for Locomotives: A 28–16 (page 206).

Revisions proposed in 1917.

These revisions are not repeated here, as they have been embodied—amended where indicated below—in the proposed revised Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes for Locomotives appended to this report.[1]

Revisions proposed this year.[2]

(NOTE.—The number (1917) indicates that the quotation which it follows was proposed by the committee last year as a revision. See *Proceedings*, Vol. XVII, Part I, pp. 101–103.)

1. *New Section 5 (a), "Flange Tests."*—Change the words "For all tubes under 6 in. in diameter" (1917) to read "For all tubes 6 in. or under in diameter." (See item No. 1, Specifications A 52.)

2. *New Section 6, "Flattening Tests."*—In Paragraph (*a*), change the words "For all tubes except superheater pipes" (1917) to read the same as proposed in 1917 for Specifications A 52–15, namely: "For all tubes, except small tubes and superheater pipes, on which the flange test is not required."

In Paragraph (*b*), change the words "For superheater pipes" (1917) to read the same as proposed in 1917 for Specifications A 52–15, namely: "For small tubes and superheater pipes on which the flange test is not required."

3. *New Section 8, "Hydrostatic Tests."*—Change from its present form to read the same as proposed in 1917 for Specifications A 52–15, by the insertion of the italicized words:

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[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.

[2] For further revisions in these specifications, see Addendum, p. 129.—ED.

"8. Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in., and tubes 5 in. or over in diameter shall stand an internal hydrostatic pressure of 800 lb. per sq. in.; *provided that the fiber stress does not exceed 16,000 lb. per sq. in., in which case the test pressure shall be determined by the following formula:*

$$P = \frac{32{,}000\,t}{D}$$

in which P = the pressure in pounds per square inch, t = the thickness of wall in inches, and D = the inside diameter of tube in inches. Lap-welded tubes shall be struck near both ends, while under the test pressure, with a 2-lb. steel hand hammer or the equivalent."

4. *New Section 10, "Number of Tests."*—Change to read as follows by the insertion of the italicized words and the omission of the words in brackets (see item No. 2, Specifications A 52):

> "10. *One of each of the physical tests specified* [One flange, one flattening and one crush test] shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test."

5. *New Section 15, "Finish."*—Change to read the same as proposed in 1917 for Specifications A 52–15, by the insertion of the italicized words and the omission of the words in brackets:

> "15. The finished tubes shall be free from injurious defects *and distortion*, and shall have a workmanlike finish. [They shall be free from kinks, bends and buckles.]

6. *New Section 16, "Marking."*—Change to read the same as proposed in 1917 for Specifications A 52–15, by the insertion of the italicized words and the omission of the words in brackets:

> "16. The name or brand of the manufacturer, *the material from which it is made, and the pressure in pounds at which it was tested,* [and 'Tested at 1000 lb.' for tubes under 5 in. in diameter, and 'Tested at 800 lb.' for tubes 5 in. or over in diameter] shall be legibly stenciled [in white] on each tube."

NO. 8.—STANDARD SPECIFICATIONS FOR LAP-WELDED AND SEAMLESS STEEL AND WROUGHT-IRON BOILER TUBES FOR STATIONARY SERVICE: A 52–15 (page 211).

Revisions proposed in 1917.

These revisions are not repeated here, as they have been embodied—amended where indicated below—in the proposed revised specifications of the above title appended to this report.[1]

Revisions proposed this year.[2]

(NOTE.—The number (1917) indicates that the quotation which it follows was proposed by the committee last year as a revision. See *Proceedings,* Vol. XVII, Part I, pp. 103–108.)

1. *New Section 5 (a), "Flange Tests."*—Change the words "For all tubes under 6 in. in diameter" (1917) to read "For all tubes 6 in. or under in diameter." (See item No. 1, Specifications A 28.)

2. *New Section 10, "Number of Tests."*—Change to read as follows by the insertion of the italicized words and the omission of the words in brackets (see item No. 4, Specifications A 28):

> "10. *One of each of the physical tests specified* [One flange and one flattening test] shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test."

NO. 9.—STANDARD SPECIFICATIONS FOR AUTOMOBILE CARBON AND ALLOY STEELS: A 29–16 (page 220).

Revision proposed in 1917.

1. *Section 5.*—In Table I, "Automobile Carbon Steels," change the present chemical requirements for screw-stock material, namely:

	DESIRED.	PERMISSIBLE RANGE.
Carbon	0.14	0.08 – 0.20 per cent
Manganese	0.55	0.30 – 0.80 "
Phosphorus	not over 0.12	...... "
Sulfur	......	0.06 – 0.12 "

[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.

[2] For further revisions in these specifications, see Addendum, pp. 129–131.—ED.

to agree with the requirements for this material in the Standard Specifications for Cold-Drawn Bessemer Steel Automatic Screw Stock (A 32–14), and for Cold-Drawn Open-hearth Steel Automatic Screw Stock (A 54–15), as follows:

BESSEMER STOCK.

Carbon	0.08 – 0.16	per cent
Manganese	0.60 – 0.80	"
Phosphorus	0.09 – 0.13	"
Sulfur	0.075 – 0.15	"

OPEN-HEARTH STOCK.

Carbon	0.15 – 0.25	per cent
Manganese	0.60 – 0.90	"
Phosphorus	not over 0.06	"
Sulfur	0.075 – 0.15	"

Revision proposed this year.

2. Amend the revision proposed in 1917 by adding the following footnote:

"The requirements for screw stock material cover a free-cutting steel suitable for high-speed screw-machine work, leaving a smooth finish after machining."

NO. 10.—STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR CARS: A 11–16 (page 86).[1]

Revisions proposed this year.

1. *Section 3.*—Add the following chemical requirements to apply to "Plates for forge welding":

Manganese		0.40 – 0.60	per cent
Phosphorus	Acid	not over 0.04	"
	Basic	" " 0.04	"
Sulfur		" " 0.045	"

2. *Section 6 (a).*—Change the heading of the last column of the table to read (italics are new) "Plates for cold pressing

[1] The proposed revisions in these specifications were subsequently withdrawn by the committee when this report was presented at the annual meeting. See Summary of Proceedings, p. 17.—ED.

and forge welding," which makes the following tensile properties apply to plates for forge welding:

Tensile strength, lb. per sq. in.	48 000 – 58 000
Yield-point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent.........	$\frac{1\,5000\,000}{\text{Tens. str.}}$, with

the same modifications which apply to plates for cold pressing.

3. *Section 8 (b)*.—Change to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "(*b*) The test specimen for rivet steel, [and] *for* plates for cold pressing, *and for plates for forge welding*, shall bend cold through 180 deg. flat on itself without cracking on the outside of the bent portion.

NO. 11.—STANDARD SPECIFICATIONS FOR BLOOMS, BILLETS AND SLABS FOR CARBON-STEEL FORGINGS: A 17–13 (page 138).

Revisions proposed in 1917.

These revisions are not repeated here, as they have been embodied without amendment in the proposed revised Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings appended to this report.[1]

Revisions proposed this year.

These revisions are referred to in the report under the heading "Billets and Forgings." They appear in Sections 2, 9 and 10 of the proposed revised specifications above referred to.

NO. 12.—STANDARD SPECIFICATIONS FOR STEEL TIRES: A 26–16 (page 195).

Revision proposed this year.

Add the following new Section 3 on "Discard," and renumber the remaining sections:

> "3. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation."

[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.

APPENDIX II.

THE RAIL SITUATION.

Owing to war conditions, the amount of rail purchased by the railroads during the past year has been much less than usual and consequently the tonnage rolled has been less. The routine work of testing at the mills has been carried out as usual, but there has of necessity been less experimental work connected with rails.

Records of performance in service of different types and weights of rails have been reported as usual and these reports are serving a useful purpose, but it is becoming more and more apparent that general summaries of these records are not going to be of a great deal of value. The difficulty is in the absence of any record of the ton mileage carried by the rail before failure. The reports of failures would be of much greater value if the comparisons in the general summaries could be made on the basis of tonnage over the rails in addition to failures per year or period of years. The general summaries do, however, show the general trend is toward a reduction in number of failures, but care should be used in making individual comparisons based on these summaries.

Straightening.—The severity of the fiber stress produced in the rail in straightening in a gag press is dependent on the length of the portion of the rail over which the stress is distributed at each blow in the gag and also on the moment of inertia of the rail section. Therefore, with the stiffer sections of the recent heavy-weight rails, it is desirable to increase the distance between the supports in the straightening presses. It is probable that the standard distance of 42 in. now prescribed in the specifications will have to be increased to meet the necessities of the heavy rails toward which the railroads are tending.

Weight of Sections.—Some of the railroads that have increased the weight of section, particularly where this is decidedly over 100 lb. per yd , report greatly reduced cost of track maintenance and reduction in number of failures as well as better riding track. One of these roads now has in contemplation a

section weighing 200 lb. per yd. While this may be extreme and only to be considered by roads having extremely dense traffic and the heaviest wheel loads, the tendency toward heavier sections seems to be general.

Heat-Treated Rails.—From time to time experiments have been made in the quenching and annealing of rails, sometimes of standard sections and sometimes of sections slightly modified to better meet the stresses incident to quenching. The rails when put in service generally showed markedly greater resistance to abrasion, but some failed due to brittleness in track. There are now in track, at points where the service is particularly severe, quenched and annealed rails which have not proven brittle, although they carry very heavy traffic under severe service conditions on heavy curves. The results of these tests indicate that the heat-treated rails may have a future.

Distortion of Rails under Wheel Pressure.—Valuable work has been done by a committee of the American Railway Engineering Association in determining the effect of wheel loads of various weights in producing distortion of the rail head. The reported results indicate that marked distortion is produced by weights considerably under those in common use to-day. The relation of this distortion to rail failures has yet to be determined, but the results already obtained throw considerable light on just what is happening to the rails in track.

ADDENDUM

TO

REPORT OF COMMITTEE A-1.

This Addendum to the Report of Committee A-1 contains reports of four sub-committees on certain matters which have been completed by the sub-committees since the last meeting of Committee A-1. These matters were accordingly left open in the report of the committee,—of which a preprint copy has been distributed to every member of the Society,—with the understanding that they will be considered by the committee at its next meeting, which will be held on the evening of June 24, just prior to the annual meeting.

1. Report of Sub-Committee I recommending proposed Tentative Specifications for Low-Carbon-Steel Track Bolts.

2. Report of Sub-Committee IX recommending further revisions in the Specifications for Steel Tubes for Locomotives (A 28–16) and for Stationary Service (A 52–15); see report of Committee A-1, pp. 110–111.

3. Report of Sub-Committee XI on Boiler and Firebox Steel recommending a revision in the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T); see report of Committee A-1, page 112.

4. Report of Sub-Committee XVI on Cast Steel Chain, recommending the adoption as tentative of proposed Tentative Specifications for Electric Cast Steel Anchor Chain; see report of Committee A-1, pages 112–113.

While these reports have not yet been acted upon by the committee, it has nevertheless been thought advisable to prepare this Addendum for distribution as information among the members of the Society in advance of the meeting, and a recommendation to that effect has been submitted to the Secretary-Treasurer.

The committee will present its recommendations concerning these reports on the floor of the meeting.

Respectfully submitted,

C. L. Warwick, *Secretary*.

J. A. Capp, *Chairman*.

REPORT OF SUB-COMMITTEE I ON RAILS.

In cooperation with a committee of the Association of American Steel Manufacturers, Sub-Committee I has prepared Specifications for Low-Carbon-Steel Track Bolts, which are appended to this report.[1] The sub-committee recommends that they be accepted for publication among the tentative standards of the Society.

REPORT OF SUB-COMMITTEE IX ON STEEL TUBES.

Revisions in Specifications A 28.—The following revisions in the Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes for Locomotives (A 28–16) are proposed by Sub-Committee IX in order to bring the sections affected into conformity with the changes in Specifications A 52–15 referred to below:

Section 6 (a).—Change the phrase:

"Shall stand flattening until the walls are in contact"

to read:

"Shall stand flattening between parallel plates until the distance between the plates is not over three times the wall thickness."

Section 6 (b).—Change the words:

"Shall stand flattening until the distance between the inside of the walls is equal to twice the thickness of the wall"

to read:

"Shall stand flattening between parallel plates until the distance between the plates is not over four times the wall thickness."

Section 14 (b).—Change the first sentence, which reads:

"The thickness at any point shall not vary more than 10 per cent over that specified.",

to read:

"The thickness at any point shall not vary more than one gage above or one gage below that specified."

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[1] See pp. 456–459.—ED.

Revisions in Specifications A-52.—The following revisions in the proposed revised Standard Specifications for Lap-Welded and Seamless Steel and Wrought-Iron Boiler Tubes for Stationary Service (A 52–15), were agreed upon at a meeting of Sub-Committee IX on Steel Tubing and Pipe, held June 3, 1918, and will be presented to Committee A-1 at its next meeting, June 24. The proposed revisions have resulted from a joint conference between representatives of the A.S.T.M. and the A.S.M.E. Boiler Code Committee and are designed to bring the specifications in agreement with those of the Boiler Code Committee, which is now considering certain changes in its own specifications looking to that end:

1. *Section 2* (*a*).—Insert a comma between the words "knobbled" and "hammered."

2. *Section 5* (*a*).—Change to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "5. (*a*) [For all tubes 6 in. or under in diameter and having a thickness less than 9 per cent of the outside diameter,] *For tubes not more than 6 in. in diameter having a thickness less than 10 per cent of the outside diameter, provided the thickness does not exceed No. 6 B.w.g.*, a test specimen *not less than 4 in. in length* shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange, as measured from the outside diameter of the tube, shall not be less than 10 per cent of the outside diameter, *provided that in no case shall the flange be less than $\frac{1}{8}$ in. or greater than $\frac{1}{2}$ in. in width.* [for wrought-iron nor less than 15 per cent of the outside diameter for steel tubes, but the flange shall in no case exceed $\frac{1}{2}$ in. in width]." *For all other tubes the flange test is not required.*

3. *Section 6* (*a*).—Change to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "6. (*a*) [For all tubes, except small tubes and superheater pipes, on which the flange test is not required, a] *A* test specimen 3 in. in length shall stand flattening *between parallel plates* until the distance between the [inside

of the walls is equal to three times the thickness of the wall] *plates is not over five times the wall thickness,* without showing cracks or flaws. For lap-welded tubes, the test shall be made with the weld at the point of maximum bend."

4. *Section 6* (*b*).—Omit.

5. *Section 7*.—Insert the word "steel" in the last sentence as indicated below in italics:

"Lap-welded tubes shall be struck near both ends, while under the test pressure, with a 2-lb. *steel* hand hammer or the equivalent."

6. *Section 8*.—Omit the word "perfectly" in the first sentence, which reads:

"A cross-section of charcoal-iron tube may be turned or ground to a [perfectly] true surface, . . ."

7. *Section 13* (*a*).—Change to read as follows by the addition of the italicized word and the omission of the words in brackets:

"13. (*a*) Finished tubes 3½ in. or under in *outside* diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 3½ in. in *outside* diameter, these variations shall not exceed 0.5 per cent of the outside diameter. [The measurements to determine whether the tubes meet these requirements shall be made near the ends of the tubes.]

REPORT OF SUB-COMMITTEE XI ON BOILER STEEL.

As stated in the report of Committee A-1 (see page 112), Sub-Committee XI has been cooperating with the Boiler Code Committee of the American Society of Mechanical Engineers, through the A.S.T.M. of representatives on a joint conference committee, in the matter of revising the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T)[1] to differentiate more sharply between boiler and firebox grades. An agreement in this matter has finally been reached between

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 557 (1917).

the Boiler Code Committee, the Association of American Steel Manufacturers and Sub-Committee XI, in pursuance of which the sub-committee recommends that the following revisions be made in these specifications:

Modify the requirements of Sections 6 and 7, which read as follows:

"6. (*a*) The material shall conform to the following requirements as to tensile properties:

	Flange and Firebox.
Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent	$\frac{1\ 500\ 000}{\text{Tens. str.}}$

'(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

"7. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 0.5 from the percentages of elongation specified in Section 6 (*a*) shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in. to a minimum of 20 per cent.

"(*b*) For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.",

by adding the following words after the third line of the table:

"But for firebox steel, not less than 24 per cent, subject to the modifications of Section 7."

The sub-committee further recommends that these specifications be continued as tentative, in order that the sub-committee may more easily modify them, if advisable, in the light of further consultation with the A.S.M.E. Boiler Code Committee.

This report has been submitted to letter ballot of the sub-committee, which consists of 17 members, of whom 14 have voted affirmatively, 1 negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the sub-committee,

F. J. COLE,
Chairman.

REPORT OF SUB-COMMITTEE XVI, ON CAST STEEL CHAIN.

Sub-Committee XVI on Cast Steel Chain was organized at a meeting held in New York on March 16, 1918. This meeting was called by authority of the chairman of Committee A-1 given on information received to the effect that the demand for anchor chain in connection with the Emergency Fleet Corporation was so great as to require some special action to provide an increased output in chain, and the consideration of methods and material for making chain other than the usual fire-welded wrought-iron chain.

The Engineering Committee of the Council of National Defense had previously given careful consideration to this subject and had conducted some investigations.

The meeting was informed of the results of tests on cast steel anchor chain which had been made by the General Electric Company and the National Malleable Castings Company, and after a general discussion of these results Sub-Committee XVI was organized as a committee on Cast Steel Chain to prepare tentative specifications based upon the information at hand or which would be further developed during the work of the sub-committee.

The personnel of the sub-committee as finally organized is as follows:

American Bureau of Shipping, G. G. Sharp.
American Clay Machinery Co., H. D. Van Doorn.
American Engineering Co., G. E. Smith.
Bethlehem Shipbuilding Corporation, H. P. Phelps.
Bradlee and Co., T. E. Newbold.
Browne, F. A. (General Purchasing Officer, U. S. Shipping Board, Emergency Fleet Corporation).
General Electric Co., W. L. Merrill.
Jones and Laughlin Steel Co., A. E. Crockett, *Secretary*.
Lewis, Wilfred (Tabor Mfg. Co.).
Lloyds' Register of Shipping, J. French.
McKay and Co., James, Robert McKay.
National Malleable Castings Co., E. P. Kittredge.
Nelson, J. H. (Bureau of Standards).
Power, C. M. (American Chain Co.).

Rigg, E. H. (New York Shipbuilding Co.).
U. S. Navy, Bureau of Construction and Repair.
Waring, F. M. (Pennsylvania Railroad Co.), *Chairman*.

Mr. H. M. Seely, of the U. S. Steamboat Inspection Service, is acting in the capacity of an Advisory Member.

Through the courtesy of Lloyd's Register of Shipping, the sub-committee was given a copy of proposed specifications prepared by them for electric cast steel anchor chain, and after discussing these the sub-committee agreed to take them as a basis for its future work. The specifications as subsequently modified by the action of the sub-committee are submitted with the recommendation that they be included in the report of Committee A-1 to the Society this year, and that Committee A-1 recommend that they be published as Tentative Specifications.

Attention is directed to the fact that in the specifications the details of shock test are left to agreement between the manufacturer and purchaser. No definite requirements can be included until the sub-committee has had further opportunity to make tests on both wrought iron and cast steel chain. Such tests are now under way.

This report has been referred to letter ballot of the sub-committee, which consists of 18 members, of whom 16 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the sub-committee,

F. M. WARING,
Chairman.

A. E. CROCKETT,
Secretary.

EDITORIAL NOTE.

The proposed revisions in the eleven standard specifications referred to in this report as Nos. 1 to 9, 11 and 12, pages 100–102, in their further revised form as indicated in the Addendum, were approved at the annual meeting and the specifications adopted by letter ballot of the Society on August 26, 1918. The specifications as thus revised appear in the 1918 Book of A.S.T.M. Standards.

The committee withdrew the proposed revisions in the Standard Specifications for Structural Steel for Cars (A 11–16), referred to as No. 10, page 102.

The four tentative specifications referred to in the report as Nos. 13 to 16, page 103, were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The proposed revisions in the Tentative Specifications for Steel Tie Plates (A 67–17 T), referred to as No. 17, page 103, and the revisions in the Tentative Specifications for Boiler and Firebox Steel for Stationary Service (A 70–17 T), proposed in the Addendum, page 131, were approved at the annual meeting and the specifications continued as tentative in their proposed revised form. The specifications as thus revised appear on pages 445 and 449, respectively.

The recommendation of the committee that the Tentative Specifications for Carbon Tool Steel (A 71–17 T) be continued as tentative was approved. The specifications appear on pages 454–455.

The proposed Tentative Specifications for Low-Carbon-Steel Track Bolts and the Tentative Specifications for Electric Cast Steel Anchor Chain, referred to in the Addendum, were accepted for publication as tentative and appear on pages 456 and 460 respectively.

DISCUSSION.

Discussion on Specifications for Structural Steel for Cars.

[Editorial Note.—The meeting had just adopted a motion by Mr. J. A. Capp, Chairman of Committee A-1 on Steel, that the following note be added to certain specifications for steel whose titles are given in the Summary of the Proceedings, pages 19–20, concerning which the recommendation of the committee had been unanimous:

"In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulfur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society."]

Mr. Capp. Mr. J. A. Capp (*Chairman of Committee A-1*).—In considering the addition of this note to certain specifications; Committee A-1 was divided. Thus, a motion in the committee, at its meeting Monday evening, to add this note to the Standard Specifications for Structural Steel for Cars (A 11–16) received 9 affirmative votes and 4 negative votes, with some 20 members not voting. I will accordingly move that the note appear under the title of Specifications A 11–16. [Motion seconded.]

Mr. Smith. Mr. H. E. Smith.—If this note is applied to these specifications, the rejection limit on sulfur will be raised to 0.0725 per cent, due to the allowance of 25 per cent excess on check analysis. Perhaps it is proper at this time to say also that, as the title indicates, these specifications apply to railroad-car material. There are now building, or about to be built, 100,000 freight cars and 1000 locomotives for the railroads of the country, to be distributed as the needs of the individual roads require. The situation with respect to the manufacture of steel has already been considered in connection with that equipment. Furthermore, it is highly probable that material ordered by

the individual roads for maintenance will follow the lead of what has been arranged with respect to new equipment. The larger tonnage of steel will come in for the cars, of course, there being many more of them than of locomotives, and the limits to be set have already been passed upon by the Council of National Defense or a committee of that Council, composed of men well informed and well qualified to speak. With respect to locomotives, the whole situation has been thoroughly reviewed by the representatives of the administration in conjunction with the locomotive builders. So much for the general situation. **Mr. Smith.**

With respect to structural steel for cars, the 0.06 per cent limit has been agreed upon for structural steel for freight cars. There are no passenger cars building by the Railroad Administration at the present time or immediately anticipated. I would suggest that the limit thus determined is a very suitable one for the American Society for Testing Materials to adopt, for it will practically be the commercial standard as long as present conditions continue. If it is necessary to review the matter again, I presume that will be done; but, in the judgment of those who have arrived at this conclusion, it covers the case for the present. I would move as an amendment, therefore, that the note as applied to these specifications be revised to make the rejection limit for sulfur 0.06 per cent. [Amendment seconded.]

Mr. Capp.—The present sulfur requirements of the specifications for structural steel and plates for cold pressing are 0.05 per cent with an allowance of 25 per cent, making the rejection limit 0.0625 per cent on check analysis. The sulfur requirements for rivet steel are 0.045 per cent, with an allowance of 25 per cent on check analysis, making the rejection limit 0.056 per cent. Therefore, the effect of Mr. Smith's amendment, if it should prevail, would be actually to lower the limit now set in the specifications with respect to structural steel and plates for cold-pressing, whereas the intention is rather to increase it. I think the amendment should not prevail, because it is in effect a step backward instead of forward. **Mr. Capp.**

Mr. Smith.—Perhaps, in view of the provision for 25 per cent allowance on check analysis, the best thing to do would be to omit the note from these specifications entirely. The **Mr. Smith.**

Mr. Smith. rejection limit on sulfur would then remain as at present, 0.0625 per cent, which is practically what we desire.

Mr. Capp. Mr. Capp.—In that case, the easiest way for Mr. Smith to accomplish his end is for him to withdraw his amendment and speak for a negative vote on the pending motion. [Mr. Smith then withdrew his amendment.]

Mr. Cromwell. Mr. O. C. Cromwell.—I should like to support Mr. Smith's statements. We find that car steel cracks very readily, due to the fact that it is subject to considerable vibration. An increase in the sulfur limits will lead to more extensive repairs, and the cars will not be in service as long as the present ones. Furthermore, since the requirements of the country for a considerable period will be covered by the cars that are being built by the government, it does not appear to be necessary at this time to make any change in the sulfur requirements of these steels.

[Mr. Capp's original motion, to add the note to Specifications A 11–16, was then adopted by a vote of 38 affirmative, 14 negative.]

Discussion on Specifications for Boiler Steel for Locomotives.

Mr. Capp. Mr. Capp.—The next specifications to be considered are the Standard Specifications for Boiler and Firebox Steel for Locomotives (A 30–16). The vote of the committee on a motion to add the note in question to these specifications was 10 affirmative and 10 negative; the remainder of the members of the committee present declined to vote and the chairman declined to cast a deciding vote. He is not going to be drawn into casting a deciding vote by making a motion at this meeting. I shall accordingly content myself with a statement of conditions and of the vote. If the members of the Society decide that action is to be taken, it must result from a motion from the floor.

Mr. Smith. Mr. Smith.—The general situation has already been covered in what was said in discussing the preceding specifications. I would accordingly move that the note in question be not applied to Specifications A 30–16. [Motion seconded.]

[This motion was lost by a vote of 24 affirmative, 28 negative.]

MR. ALBERT LADD COLBY.—I move that the note in question shall be added to these specifications. [Motion seconded.] Mr. Colby.

MR. J. H. GIBBONEY.—We hesitate to discuss in open meeting this question of sulfur limitation for firebox and boiler steel, since this matter was given such careful consideration at a recent meeting of the committee, which failed to reach a conclusion in any measure satisfactory to the railroad and locomotive builders' representatives present. To bring such a question from a technical committee to the floor of this annual meeting for adjustment is to us most unfortunate. It is common knowledge that the railroads have long recognized the necessity for surrounding locomotive materials with highly specialized inspection, the firebox and boiler materials, on account of their severe service requirements, receiving particular consdieration. These plates are generally tested as separate units of a melt of steel, which practice has in large measure resulted in the setting aside at mills of melts having very desirable composition and structural properties. Experience has amply demonstrated that such rigid inspection requirements are fully justified and such practice has unquestionably resulted in a safer and longer service for locomotive fireboxes. In the present emergency we should all strive to keep the power of the railroads at maximum efficiency by reducing to an absolute minimum the possibilities for locomotive failures. The raising of the sulfur limit for firebox and boiler materials is therefore viewed with considerable apprehension by the railroad and locomotive builders' representatives, and we should regret to see this body pass on this important matter without full information as to the possible consequence of such action. We trust, therefore, that the motion to increase the sulfur limit in these materials will not prevail. Mr. Gibboney.

MR. ROBERT JOB.—I heartily concur with the remarks just made by Mr. Gibboney. It seems to me very unfortunate that a matter of this kind should be settled on the floor of our annual meeting. As Mr. Gibboney has said, all such matters as this, involving special skill, and particularly matters concerned directly with the safety of the traveling public, should Mr. Job.

Mr. Job. be settled in committee, where there is a body of men especially able to pass on them.

Mr. Shuman. MR. J. J. SHUMAN.—Conditions as they are in the steel business are not fully realized by the public at large. The sources for the usual low-phosphorus and low-sulfur elements that enter into the making of steel have so changed that it is out of the question to achieve the low percentages that have been possible all through these years. This is not a theory, it is a condition. I wish to remove, if I can, the unfavorable impression that might have been gained through the appearance on the floor, first of steel men and then of railroad men on opposite sides. I want the members to understand that the steel men know why they are voting for this change, and if we vote now on the side of these railroad men, it is not simply because we realize the justice of what has been stated on their side, but chiefly because we are unwilling to put the American Society for Testing Materials in the position of making an *ex parte* decision.

Mr. Cromwell. MR. CROMWELL.—I believe that if the members present appreciated the conditions to which the steel in locomotive fireboxes is subjected, they would not hesitate to vote against the motion before us. The smallest nick on the face or on any part of the steel in the firebox rapidly extends and cracks. Under the very frequent and almost instantaneous changes in temperature to which the firebox is subject, those cracks develop very rapidly. Different means of staying and supporting the sheets have been adopted in the effort to overcome any undue stresses in the firebox induced by such cracks; in other words, to prevent the extension of the cracks and to prolong the life of the firebox. Small cracks frequently radiate from the staybolt holes, extending from one hole to another; at times they extend from rivet hole to rivet hole. In caulking the edges of leaky seams, the metal is stretched and further cracking is induced. To correct this condition, the rivet and staybolt holes in the firebox sheets are now drilled instead of punched, in order to reduce the strain of the metal around the hole. The higher pressures adopted for the new boilers in the United States standard locomotive will increase the severity of the conditions to which the firebox sheets are subject.

To increase the allowable sulfur content of the firebox steel in view of the conditions just enumerated, will result in shorter life of the firebox and necessitate more frequent repair of locomotives—a very serious matter in view of present traffic conditions. **Mr. Cromwell.**

MR. C. F. W. RYS.—The manufacturers certainly sympathize with the users of this steel, but we are talking about a condition which is with us and cannot be changed. We also realize the conditions Mr. Cromwell has just mentioned. But I do not want you to gain the impression that sulfur alone is the cause of all the trouble that is met with. There seems to be a belief that the chemical composition, especially sulfur content, determines the quality of firebox steel, but it does not to any large extent; the quality of firebox steel depends on something entirely different from the chemical composition, including sulfur. I wanted to state this so you will know that the manufacturers of steel have other things to take into consideration that the chemical composition alone. **Mr. Rys.**

THE CHAIRMAN (MR. GUILLIAEM AERTSEN).—Is there any further discussion? If not, I shall put the motion, which is that the note shall be added under the title of the Standard Specifications for Boiler and Firebox Steel for Locomotives (A 30–16). **Mr. Aertsen.**

[The motion was lost by unanimous vote.]

REPORT OF COMMITTEE A-2
ON
WROUGHT IRON.

During the past year one general meeting of the committee has been held at which proposed changes in the form and substance of the standards and tentative standards for wrought iron were carefully considered. The changes are given in detail in the Appendix to this report, and are divided into: (I) Proposed revisions in standards, and (II) proposed revisions in tentative standards. While with one exception (see under Specifications A 41–13) the proposed revisions in standards are here presented for the first time, the committee recommends that they be referred to letter ballot this year, instead of being printed as tentative. They are of such a nature, being either changes in form or of relatively minor importance as affecting substance, that this action might well be taken—especially since the changes are in the main designed to harmonize the specifications for wrought iron with each other and with similar steel specifications, notably with respect to the inspection and rejection of material. Since the Book of A.S.T.M. Standards will be published again this year, a convenient opportunity of making these desirable revisions is thus presented.

The recommendations of the committee, with brief comments thereon, are as follows:

I. Proposed Revisions in Standards.

Specifications for Charcoal-Iron Boiler Tubes (A 38–16)[1].—The changes recommended are desirable in order to harmonize these specifications with the Specifications for Steel Boiler Tubes (A 28–16 and A 52–15). The proposed change in the requirements of the hydrostatic test (Section 5) has been before the Society for one year[2] in the form of a proposed revision of the Standard Specifications for Steel Boiler Tubes for Stationary

[1] 1916 Book of A.S.T.M. Standards, p. 312.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 104 (1917).

Service (A 52–15), but has not previously been proposed for Specifications A 38. The proposed change in Section 7 on "Test Specimens" makes that section read exactly the same as the corresponding Section in the Specifications for Steel Boiler Tubes for Locomotives (A 28–16). The proposed change in the Table of Standard Minimum Weights is designed to express the weights corresponding to the Birmingham wire gage as standard, changing the decimal gage to conform, in line with the recommendation last year of Committee A-1 on Steel with respect to the specifications for steel boiler tubes.

The committee recommends that the proposed revisions in these specifications be referred to letter ballot of the Society.

The committee also has under consideration, in cooperation with Committee A-1, a change in Section 11 on "Workmanship", and expects to present its recommendation on the floor of the meeting.[1]

Specifications for Staybolt Iron (A 39–14).[2]—Reference is made below to these specifications in connection with revisions in tentative standards.

Specifications for Engine-Bolt Iron (A 40–13).[3]—The revisions recommended in these specifications are either ones of form or minor ones affecting substance, and the committee recommends that they be referred to letter ballot of the Society.

Specifications for Refined Wrought-Iron Bars (A 41–13).[4]—Last year the committee presented for publication in the Proceedings a proposed revision of Section 4 of these specifications.[5] This revision has been amended somewhat as to wording, and it is proposed to interchange Sections 3 and 4.

The committee recommends that the proposed revisions in these specifications be referred to letter ballot of the Society.

Specifications for Wrought-Iron Plates (A 42–13).[6]—As in the case of Specifications A 40, the revisions proposed in these specifications are of relatively minor importance, and the committee recommends that they be referred to letter ballot of the Society.

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[1] See Addendum to this report, p. 155.—ED.

[2] 1916 Book of A.S.T.M. Standards, p. 315.

[3] *Ibid.*, p. 318. [4] *Ibid.*, p. 322.

[5] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 131 (1917).

[6] 1916 Book of A.S.T.M. Standards, p. 326.

Specifications for Iron and Steel Chain (A 56-15).[1]—The revisions recommended in these specifications have to do with form only, and the committee asks the approval of the meeting for authority to make these changes.

II. PROPOSED REVISIONS IN TENTATIVE STANDARDS.

Specifications for Staybolt Iron (A 39-17 T).—These specifications were presented by the committee last year as a proposed revision of the present Standard Specifications for Staybolt Iron (A 39-14), and were published in the Proceedings among the Tentative Standards.[2] The committee recommends that these tentative specifications be revised as to form as indicated in the Appendix, and referred to letter ballot of the Society for adoption as standard, with the understanding that if adopted they will supersede the present Standard Specifications for Staybolt Iron.

Specifications for Wrought-Iron Pipe (A 72-17 T).—These specifications have been printed as tentative for one year,[3] and consist of those sections of the present Standard Specifications for Welded Steel and Wrought-Iron Pipe (A 53-15) which apply to wrought iron, modified in accordance with the joint recommendations of Committees A-1 and A-2 proposed last year.[4] The changes in Specifications A 72 recommended in the Appendix to this report bring these specifications into entire agreement as to form with the proposed revised Standard Specifications for Welded Steel Pipe which Committee A-1 will recommend at this annual meeting for adoption. The committee accordingly recommends that the Tentative Specifications for Wrought-Iron Pipe be revised as indicated in the Appendix, and referred to letter ballot of the Society for adoption as standard.

Specifications for Wrought-Iron Blooms and Forgings (A 73-17 T).—The committee recommends that these specifications, which have been published for one year as tentative,[5] be revised as indicated in the Appendix, and referred to letter ballot of the Society for adoption as standard.

The letter ballot of the committee on the above recommendations is as follows:

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[1] 1916 Book of A.S.T.M. Standards, p. 329.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 564 (1917).

[3] *Ibid.*, p. 568. [4] *Ibid.*, p. 108. [5] *Ibid.*, p. 573.

Recommendations.	Affirmative.	Negative.	Not Voting.
I. TO REFER PROPOSED REVISIONS IN THE FOLLOWING STANDARD SPECIFICATIONS TO LETTER BALLOT:			
For Lap-Welded Charcoal-Iron Boiler Tubes, Boiler Flues, Safe Ends, and Arch Tubes for Locomotives (A 38-16)	17	0	2
For Engine-Bolt Iron (A 40-13)	17	0	2
For Refined Wrought-Iron Bars (A 41-13)	17	0	2
For Wrought-Iron Plates (A 42-13)	15	0	4
For Iron and Steel Chain (A 56-15). (Changes in form only)	15	0	4
II. TO REFER THE FOLLOWING TENTATIVE SPECIFICATIONS, AS REVISED, TO LETTER BALLOT:			
For Staybolt Iron (A 39-17 T)	17	0	2
For Wrought-Iron Pipe (A 72-17 T)	15	0	4
For Wrought-Iron Rolled or Forged Blooms and Forgings for Locomotives and Cars (A 73-17 T)	16	0	3

With respect to specifications for larger wrought-iron forgings, such, for example, as must be built up on a porter bar, the committee has made inquiries of numerous large engine and machinery builders who might be purchasers, but finds that the majority of them use steel, and that there is no demand for such a specification.

The committee has under consideration for the work of the coming year the following subjects:

1. Definition of terms applied to various grades of wrought iron;
2. Investigation of "Bushelled Steel;"
3. Further study of the vibratory test;
4. Specifications for hollow staybolt iron.

This report has been referred to letter ballot of the committee, which consists of 42 members, of whom 19 have voted affirmatively, none negatively, and 23 have refrained from voting.

Respectfully submitted on behalf of the committee,

H. E. SMITH,
Chairman.

J. B. YOUNG,
Secretary.

EDITORIAL NOTE.

For Addendum to this report, see page 155.

APPENDIX.

PROPOSED REVISIONS IN SPECIFICATIONS FOR WROUGHT IRON.

In this appendix are given in detail proposed revisions in certain standards and tentative standards which the committee recommends be referred to letter ballot of the Society for adoption. After the title of each specification, its serial designation and the page number of the publication where it appears in its present form, are given.

PROPOSED REVISIONS IN STANDARDS.

STANDARD SPECIFICATIONS FOR LAP-WELDED CHARCOAL-IRON BOILER TUBES, BOILER FLUES, SAFE ENDS, AND ARCH TUBES FOR LOCOMOTIVES: A 38–16.

(1916 Book of Standards, p. 312.)

Revisions in Substance.

1. *Section 5.*—Change from its present form, namely:

> "5. Each tube shall stand an internal hydraulic pressure of between 500 and 750 lb. per sq. in.",

to read:

> "6. Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in., and tubes 5 in. or over in diameter shall stand an internal hydrostatic pressure of 800 lb. per sq. in.; provided that the fiber stress does not exceed 16,000 lb. per sq. in., in which case the test pressure shall be determined by the following formula:
>
> $$P = \frac{32,000\ t}{D}$$
>
> in which P = the pressure in pounds per square inch, t = the thickness of wall in inches, and D = the inside diameter of

tube in inches. Lap-welded tubes shall be struck near both ends, while under the test pressure, with a 2-lb. steel hand hammer or the equivalent."

2. *Section 7.*—Change from its present form, namely:

"7. Test specimens shall consist of sections cut from a tube. They shall be smooth on the ends and free from burrs.",

to read:

"8. (*a*) Test specimens shall consist of sections cut from tubes selected by the inspector representing the purchaser from the lot offered for shipment. They shall be smooth on the ends and free from burrs.

"(*b*) All specimens shall be tested cold."

3. *Section 10.*—Change the present Table I on Standard Weights, in which the weights are given for certain decimal thicknesses as standard, to the following, in which the weights are given for Birmingham wire gage as standard:

TABLE I.—STANDARD WEIGHTS.

THICKNESS.		WEIGHT, LB. PER FT. OF LENGTH. Outside Diameter, in.												
In.	B.w.g.	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{1}{2}$	6
0.095	13	1.65	1.90	2.14	2.39	....	....	....	....	....	....	....	....	....
0.109	12	1.87	2.16	2.44	2.73	3.30	....	....	....	....	....	....	....	....
0.120	11	2.05	2.36	2.68	2.99	3.62	4.25	....	....	....	....	....	....	....
0.134	10	2.27	2.62	2.97	3.32	4.02	4.72	5.42	....	....	....	....	....	....
0.148	9	2.48	2.87	3.25	3.64	4.42	5.19	5.97	6.74	7.51	7.91	8.10	8.29	9.06
0.165	8	....	....	....	4.03	4.90	5.76	6.62	7.48	8.35	8.78	9.00	9.21	10.07
0.180	7	....	....	....	4.37	5.31	6.25	7.20	8.14	9.08	9.55	9.79	10.02	10.96

4. *Section 13.*—Change from its present form, namely:

"13. 'Knobbled charcoal, tested to 500 lb. pressure', shall be legibly marked at the middle of the length of each tube.",

to read:

"14. The name or brand of the manufacturer, the words 'Knobbled Charcoal', and the pressure in pounds at which it was tested, shall be legibly stenciled on each tube."

Revisions in Form.

5. Change title to read "Standard Specifications for Lap-Welded Charcoal-Iron Boiler Tubes for Locomotives."

6. Add the following new Section 1 on "Material Covered", and change the remaining section numbers accordingly:

"1. These specifications cover lap-welded charcoal-iron boiler tubes, boiler flues, safe ends, and arch tubes for locomotives."

7. *Section 8.*—Change from its present form, namely:

"8. One tube from each lot of 250 or fraction thereof shall be tested as specified in Sections 2, 3, and 4. Each tube shall be tested as specified in Section 5.",

to read:

"9. One of each of the physical tests specified shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test."

8. *Section 12.*—Change to read as follows by the insertion of the italicized words, and the omission of the words in brackets:

"13. The finished tubes shall [have a smooth surface, free from laminations, cracks, blisters, pits, and imperfect welds,] *be free from injurious defects and distortion*, and shall have a workmanlike finish. [They shall be free from kinks, bends and buckles, and evidences of unequal contraction in cooling or injury in manipulation.]"

9. *Section 14.*—Change the last sentence to read as follows by the insertion of the italicized words:

"All tests and inspection shall be made at the place of manufacture prior to shipment, *unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.*"

STANDARD SPECIFICATIONS FOR ENGINE-BOLT IRON: A 40–13.

(1916 Book of Standards, p. 318.)

Revisions in Substance.

1. *Section 3* (*b*).—Change the specified speed of the cross-head of the testing machine from "not to exceed $1\frac{1}{2}$ in. per minute" to "not to exceed $\frac{3}{4}$ in. per minute."

2. *Section 8* (*b*).—Change to read as follows by the insertion of the italicized words:

"(*b*) If any test specimen from either of the bars originally selected to represent a lot of material contains surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, *the individual bar shall be rejected and* one retest from a different bar will be allowed."

Revisions in Form.

3. Add the following new Section 12 (*c*):

"(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works."

4. Add the following new Section 13 (*b*):

"(*b*) Unless otherwise specified, any rejection based on tests made in accordance with Section 12 (*b*) shall be reported within five working days from the receipt of samples."

5. Add the following new Section 14 on "Rehearing":

"14. Samples tested in accordance with Section 12 (*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time."

STANDARD SPECIFICATIONS FOR REFINED WROUGHT-IRON BARS: A 41–13.

(1916 Book of Standards, p. 322.)

Revisions in Substance.

1. *Section 2* (*b*).—Make the same change as in item No. 1 of Specifications A 40.

2. *Section 3.*—Change to Section 4, to read as follows by the insertion of the italicized words:

"4. Twenty per cent of the test specimens representing one size may show tensile strengths 1000 lb. per sq. in. under or 5000 lb. per sq. in. over that specified in Sections 2 *and 3*; but no specimen shall show a tensile strength less than 45,000 lb. per sq. in."

3. Change the present Section 4, namely:

"For flat bars which have to be reduced in width, a deduction of 1000 lb. per sq. in. from the tensile strength specified in Sections 2 and 3 shall be made.",

to Section 3 to read:

"3. For material over 4 sq. in. in sectional area, a reduction of 500 lb. per sq. in. from the tensile strength specified in Section 2 will be permitted for each additional 2 sq. in., and a proportionate amount of reduction for fractional parts thereof; provided that the tensile strength shall not be less than 45,000 lb. per sq. in."

4. *Section 9 (b).*—Change to read as follows by the insertion of the italicized words:

"(*b*) If any test specimen from the bar originally selected to represent a lot of material contains surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, *the individual bar shall be rejected and* one retest from a different bar will be allowed."

Revisions in Form.

5. Add new Sections 12 (*c*), 13 (*b*) and 14 as indicated in items Nos. 3, 4 and 5, respectively, under Specifications A 40.

STANDARD SPECIFICATIONS FOR WROUGHT-IRON PLATES: A 42–13.

(1916 Book of Standards, p. 326.)

Revisions in Substance.

1. *Section 3 (b).*—Make the same change as in item No. 1 of Specifications A 40.

2. Add the following new Section 9 on "Marking":

"9. The plates shall be stamped or otherwise marked as designated by the purchaser."

Revisions in Form.

3. Change the present Section 9 to 10, and add new Sections 10 (*c*), 11 and 12 as indicated in items Nos. 3, 4 and 5, respectively, under Specifications A 40; except that the reference in these items to Section 12 (*b*) should here be to Section 10 (*b*).

STANDARD SPECIFICATIONS FOR IRON AND STEEL CHAIN: A 56–15.

(1916 Book of Standards, p. 329.)

Revisions in Form.

1. *Section 12* (*a*).—Add the following sentence:

"Tests and inspection at the place of manufacture shall be made prior to shipment".

2. Add a new Section 14 on "Rehearing" reading the same as item No. 5 under Specifications A 40.

PROPOSED REVISIONS IN TENTATIVE STANDARDS.

TENTATIVE SPECIFICATIONS FOR STAYBOLT IRON: A 39–17 T.

(Proceedings, Vol. XVII, Part I, p. 564.)

Revisions in Form.

1. Change Section 14 (*b*) to 14 (*c*), and add new Sections 13 (*c*), 14 (*b*) and 15 as indicated in items Nos. 3, 4 and 5, respectively, under Specifications A 40; except that the reference in these items to Section 12 (*b*) should here be to Section 13 (*b*).

TENTATIVE SPECIFICATIONS FOR WROUGHT-IRON PIPE: A 72–17 T.

(Proceedings, Vol. XVII, Part I, p. 568.)

Revisions in Substance.

1. *Section 13* (*a*).—Change the second sentence, namely:

> "For pipe 2 to 6 in., inclusive, the outside diameter shall not vary more than 1 per cent over nor more than $\frac{3}{64}$ in. under the standard.",

to read:

> "For pipe 2 in. or over in inside diameter, the outside diameter shall not vary more than 1 per cent over or under the standard size."

Revisions in Form.

2. In the title, insert the word "Welded" before the words "Wrought-Iron Pipe".

3. Add the following new Section 1 on "Material Covered", and change the remaining section numbers accordingly:

> "1. These specifications cover 'standard' and 'extra-strong' welded wrought-iron pipe, but not 'double extra strong' pipe".

TENTATIVE SPECIFICATIONS FOR WROUGHT-IRON ROLLED OR FORGED BLOOMS AND FORGINGS FOR LOCOMOTIVES AND CARS: A 73–17 T.

(Proceedings, Vol. XVII, Part I, p. 573.)

Revisions in Substance.

1. *Sections 9 and 10.*—Change these sections on "Workmanship" and "Finish," respectively, which read:

> "9. The blooms and forgings shall be in accordance with the drawings furnished by the purchaser.
>
> "10. The blooms and forgings shall be free from injurious seams, cracks, evidence of overheating and other defects.",

to read:

"10. The blooms and forgings shall conform to the sizes and shapes specified by the purchaser. When centered, 60-deg. centers with clearance drilled for points shall be used.

"11. The blooms and forgings shall be free from injurious defects and shall have a workmanlike finish."

2. Add the following new Section 12 on "Marking":

"12. Identification marks shall be legibly stamped on each bloom or forging and on each test specimen. The purchaser shall indicate the location of such identification marks."

Revisions in Form.

3. *Section 4 (b).*—Change from its present form, namely:

"An analysis may be made by the purchaser from each specimen used for the tension test. The drillings or chips taken for analysis shall represent the full cross-section of the test specimen.",

to a new Section 5 on "Check Analyses" reading:

"5. (*a*) An analysis may be made by the purchaser from each specimen used for the tension test. The chemical composition thus determined shall conform to the requirement specified in Section 4.

"(*b*) Drillings or chips for analysis shall be so taken as to represent the full cross-section of the specimen."

4. *Section 6.*—Add the following footnote:

"A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulfuric acid is recommended for the etch test."

5. *Section 7.*—Change from its present form, namely:

"7. All tension test specimens shall be taken from a full-size prolongation of the bloom or forging, the axis of the specimen being parallel to the axis of the bloom or forging and midway between its center and outside. They shall be turned to a reduced cross-section $\frac{7}{8}$ in. in diameter

and shall be $4\frac{1}{4}$ in. long between fillets. The ends of the test specimens may be of any form which will fit the holders of the testing machine.",

to read:

"8. (*a*) Tension test specimens shall be taken from a full-size prolongation of the bloom or forging. The axis of the specimen shall be located at any point midway between the center and surface of the bloom or forging,

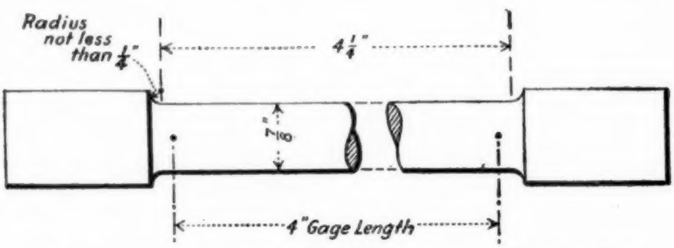


FIG. 1.

and shall be parallel to the axis of the bloom or forging.

"(*b*) The specimens shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial."

6. In Sections 12 (*a*) on "Rejection" and 13 on "Rehearing," change "Section 4 (*b*)" to read "Section 13 (*b*)."

(NOTE.—This reference is really to Section 11 (*b*) of the present specifications, but Section 11 will be changed to Section 13 owing to the addition of two new sections.)

ADDENDUM
TO
REPORT OF COMMITTEE A-2.

Referring to the statement in the report that Committee A-2 has under consideration a change in Section 11 of the Standard Specifications for Charcoal-Iron Boiler Tubes (A 38–16) and expects to present its recommendation on the floor of the meeting, the committee recommends the following revision in this section:

Change the present Section 11, to read:

"(*a*) Finished tubes $3\frac{1}{2}$ in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over $3\frac{1}{2}$ in. in outside diameter these variations shall not exceed 0.5 per cent of the outside diameter.

"(*b*) The thickness at any point shall not vary more than one gage above or one gage below that specified. In the case of boiler tubes which are expanded and swaged, the thickness of the expanded end may be $1\frac{1}{2}$ gages lighter, and of the swaged end 2 gages heavier than the thickness specified.

"(*c*) The length shall not be less, but may be 0.125 in. more than that ordered."

Editorial Note.

The proposed revisions in the five standard specifications referred to in this report and the above addendum were approved at the annual meeting and subsequently adopted by letter ballot of the Society on August 26, 1918. The specifications as thus revised appear in the 1918 Book of A.S.T.M. Standards.

The three tentative specifications referred to in the report were approved at the annual meeting in their proposed revised form and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

REPORT OF COMMITTEE A-3

ON

CAST IRON.

During the past year the work of Committee A-3 has been confined to the study of several problems in connection with the standard specifications for cast iron now in force. Two general points will be of interest, namely, the introduction of a hardness test, and the behavior of cast iron under the effects of super-heated steam.

The sub-committees engaged in contemplated revision of specifications have had a number of meetings during the year, but will not submit their results until further cooperation with other bodies interested in the same subjects is again possible—many of these bodies having suspended activities during the period of the war.

Specifications for Soil Pipe and Fittings.—Five hundred copies of the Tentative Specifications for Cast-Iron Soil Pipe and Fittings (A 74–17 T)[1] have been sent out to all the important manufacturers of this foundry product, as well as to probably all the plumbing inspectors of the country. Criticism and suggestions were asked for. Commendation came from all sides and not a single criticism. Your committee accordingly recommends that these specifications be referred to letter ballot of the Society for adoption as standard.

Specifications for Railroad Malleable-Iron Castings.—No criticisms of the Tentative Specifications for Railroad Malleable-Iron Castings (A 75–17 T) have been received since their publication as tentative.[2] Your committee therefore recommends that these specifications also be referred to letter ballot of the Society for adoption as standard.[3]

Specifications for Gray-Iron Castings.—Last year the committee recommended[4] as tentative that the maximum sulfur

[1] *Proceedings*, Am. Soc. Test Mats., Vol. XVII, Part I, p. 576 (1917).

[2] *Ibid.*, p. 582.

[3] This recommendation was withdrawn at the annual meeting. See Editorial Note on following page.—Ed.

[4] *Ibid.*, p. 135.

limit in light castings in the Standard Specifications for Gray-Iron Castings (A 48–05) be increased from 0.08 to 0.10 per cent. The committee now recommends that this revision be referred to letter ballot of the Society for adoption as standard.

This report has been submitted to letter ballot of the committee, which consists of 47 members, of whom 40 have voted affirmatively, none negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

GEORGE C. DAVIES,
Secretary.

EDITORIAL NOTE.

The Tentative Specifications for Cast-Iron Soil Pipe and Fittings referred to in this report were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The recommendation of the committee that the Tentative Specifications for Railroad Malleable Castings be referred to letter ballot of the Society for adoption as standard was, on motion of Mr. Moldenke, withdrawn from the report and the specifications were placed in the charge of the newly organized Committee A-7 on Malleable Castings. (For further action relative to these specifications, see special report of Committee A-7, Summary of Proceedings, page 29.)

The proposed revision in the Standard Specifications for Gray-Iron Castings referred to in the report was approved at the annual meeting and subsequently adopted by letter ballot of the Society on August 26, 1918. The specifications as thus revised appear in the 1918 Book of A.S.T.M. Standards.

REPORT OF COMMITTEE A-5

ON

CORROSION OF IRON AND STEEL.

The extensive corrosion tests which were formulated in 1915 have now progressed so that certain results are being obtained. The various sheets which were exposed at Pittsburgh, Pa., and Annapolis, Md., in October and December of 1916, and at Fort Sheridan, Ill., in April 1917, have been inspected during April and October of each year since the test was started.

As might be expected, the exposure of the sheets under normal atmospheric conditions at Fort Sheridan and Annapolis has been too short to develop failure in any of the sheets, but under the more severe conditions at Pittsburgh some failures are reported.

In all these inspections, the committee has endeavored to record as accurately as possible, the texture, color and adherence of the rust on each sheet so that as the test progressed it might be determined if these early characteristics bear any relation to the ultimate life of the sheet.

The detailed results of these inspections are the subject of the report of the Sub-Committee on Inspection which is attached as Appendix II to this report.

There is also appended to this year's report (Appendix I) tabulations giving the result of analyses of all the special sheets included in Series B and certain additional sheets in Series A which were not included in the previous reports.

The report of Sub-Committee II on Preservative Metallic Coatings for Metals, consists of an investigation on the "Structure of Commercial Zinc Coatings" by the secretary of the sub-committee, Henry S. Rawdon of the Bureau of Standards, and is attached to this report as Appendix III.

A report on "Method of Making the Salt-Spray Corrosion Test," by A. N. Finn, is attached to this report as Appendix IV.

Committee C-11 on Gypsum has requested information on the corrosion of steel reinforcement in gypsum plasters and blocks, and has asked this committee to investigate this subject. It is

believed that this investigation should be undertaken as a corrosion problem and a sub-committee of this committee is in process of organization which will call on members of the Gypsum and Cement Committees to assist in this investigation.

This report has been submitted to letter ballot of the committee, which consists of 39 members, of whom 36 have voted affirmatively, 1 negatively, and 2 have refrained from voting.

Rspectfully submitted on behalf of the committee,

S. S. VOORHEES,
Chairman.

EDITORIAL NOTE.

In presenting the Report of Committee A-5 the chairman, Mr. S. S. Voorhees, read a resolution which the committee had adopted relating to the death under tragic circumstances of one of its members, Mr. Robert B. Carnahan, Jr. This resolution was accepted as an appendix to the report of the committee and was ordered spread upon the minutes of the meeting. It appears in the Summary of the Proceedings, page 23.

For Discussion of this report, see page 240.

APPENDIX I.

ANALYSIS OF STEEL SHEETS, SERIES "A," FOR CORROSION TESTS.

TABLE I.—No. 16 GAGE COPPER-BEARING PURE IRON, SERIES A. MARKED *CCC*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.03	0.022	0.005	0.023	....	0.236	none
2	0.03	0.020	0.006	0.023	....	0.25	none
3	0.03	0.025	0.004	0.025	....	0.242	none
4	0.03	0.030	0.005	0.022	....	0.23	none
5	0.03	0.021	0.006	0.023	0.002	0.236	none
6	0.03	0.020	0.004	0.026	....	0.23	....
7	0.03	0.021	0.006	0.024	....	0.222	....
8	0.03	0.022	0.004	0.022	....	0.236	....
9	0.03	0.021	0.004	0.025	....	0.234	....
10	0.03	0.028	0.005	0.042	0.006	0.278	trace
11	0.016	0.030	0.004	0.035	0.006	0.276	trace
12	0.02	0.03	0.006	0.032	0.006	0.26	trace
13	0.012	0.028	0.005	0.038	0.006	0.274	trace
14	0.016	0.028	0.005	0.040	0.006	0.27	trace
15	0.010	0.028	0.004	0.030	0.006	0.264	trace
16	0.021	0.030	0.004	0.033	0.006	0.26	trace
17	0.019	0.030	0.006	0.034	0.006	0.27	trace
18	0.019	0.028	0.006	0.034	0.006	0.27	trace
19	0.024	0.03	0.011	0.026	trace	0.216	0.01
20	0.024	0.02	0.004	0.026	trace	0.216	0.02
21	0.024	0.03	0.004	0.026	trace	0.22	0.01
22	0.024	0.03	0.006	0.025	trace	0.224	0.015
23	0.034	0.03	0.006	0.025	trace	0.216	0.01
24	0.03	0.03	0.006	0.026	trace	0.216	0.015
25	0.024	0.03	0.004	0.027	trace	0.216	0.01
26	0.034	0.03	0.006	0.027	trace	0.22	0.02
27	0.034	0.02	0.006	0.028	trace	0.228	0.01
28	0.015	0.026	0.005	0.023	0.005	0.23	....
29	0.015	0.026	0.005	0.029	0.005	0.205	....
30	0.015	0.026	0.005	0.025	0.005	0.217	....
31	0.015	0.026	0.005	0.024	0.005	0.22	....
32	0.015	0.026	0.005	0.026	0.005	0.22	....
33	0.015	0.026	0.005	0.027	0.005	0.223	....
34	0.015	0.026	0.005	0.028	0.005	0.227	....
35	0.015	0.026	0.005	0.024	0.005	0.217	....
36	0.015	0.026	0.005	0.025	0.005	0.223	....

TABLE II.—NO. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL, SERIES A. MARKED *O*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.14	0.528	0.008	0.027	0.26	0.015	....
2	0.13	0.525	0.007	0.026	0.26	0.016	....
3	0.12	0.51	0.008	0.027	0.24	0.015	....
4	0.112	0.52	0.009	0.031	0.26	0.012	....
5	0.11	0.52	0.010	0.029	0.27	0.014	....
6	0.14	0.50	0.013	0.028	0.24	0.016	....
7	0.14	0.50	0.015	0.027	0.24	0.012	....
8	0.13	0.53	0.007	0.032	0.24	0.014	....
9	0.08	0.50	0.011	0.033	0.24	0.013	....
10	0.11	0.51	0.008	0.032	....	0.032	none
11	0.11	0.50	0.004	0.032	....	0.027	none
12	0.11	0.51	0.005	0.033	....	0.035	none
13	0.11	0.51	0.007	0.033	....	0.032	none
14	0.11	0.51	0.010	0.029	....	0.027	none
15	0.11	0.51	0.009	0.029	....	0.034	none
16	0.11	0.52	0.008	0.028	....	0.029	none
17	0.11	0.52	0.009	0.029	0.21	0.030	none
18	0.11	0.53	0.005	0.029	....	0.034	none
19	0.11	0.57	0.010	0.035	0.238	0.028	....
20	0.11	0.57	0.008	0.035	0.236	0.030	....
21	0.11	0.57	0.009	0.031	0.236	0.029	....
22	0.11	0.57	0.010	0.034	0.238	0.029	....
23	0.11	0.57	0.007	0.037	0.229	0.028	....
24	0.11	0.57	0.010	0.033	0.463	0.030	....
25	0.109	0.57	0.011	0.034	0.236	0.029	....
26	0.11	0.57	0.010	0.032	0.236	0.030	....
27	0.11	0.57	0.010	0.033	0.448	0.030	....
28	0.15	0.54	0.012	0.027	0.22	0.016	trace
29	0.15	0.54	0.007	0.027	0.22	0.024	trace
30	0.15	0.54	0.006	0.027	0.22	0.024	trace
31	0.13	0.55	0.007	0.026	0.21	0.016	trace
32	0.15	0.55	0.006	0.027	0.23	0.016	trace
33	0.14	0.54	0.006	0.027	0.23	0.012	trace
34	0.13	0.54	0.008	0.028	0.20	0.016	trace
35	0.14	0.55	0.007	0.028	0.22	0.012	trace
36	0.14	0.55	0.007	0.027	0.20	0.012	trace

TABLE III.—NO. 16 GAGE LOW-COPPER OPEN-HEARTH STEEL, SERIES A. MARKED *OO*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.09	0.357	0.014	0.027	trace	0.020	....
2	0.10	0.36	0.011	0.027	trace	0.018	....
3	0.12	0.36	0.010	0.029	trace	0.022	....
4	0.11	0.37	0.011	0.029	trace	0.02	....
5	0.12	0.36	0.010	0.03	trace	0.022	....
6	0.12	0.35	0.012	0.030	trace	0.018	....
7	0.12	0.35	0.008	0.032	trace	0.022	....
8	0.09	0.36	0.008	0.027	trace	0.021	....
9	0.13	0.37	0.013	0.034	trace	0.023	....
10	0.11	0.37	0.005	0.029	....	0.064	....
11	0.11	0.37	0.005	0.030	....	0.048	....
12	0.11	0.37	0.006	0.029	....	0.059	....
13	0.11	0.36	0.006	0.026	....	0.048	....
14	0.11	0.37	0.005	0.029	....	0.043	....
15	0.10	0.36	0.008	0.026	....	0.051	....
16	0.11	0.36	0.007	0.028	0.01	0.048	....
17	0.11	0.36	0.008	0.029	....	0.043	....
18	0.11	0.36	0.008	0.033	....	0.051	....
19	0.09	0.38	0.014	0.034	0.009	0.029	....
20	0.09	0.38	0.010	0.035	0.009	0.028	....
21	0.10	0.38	0.009	0.035	0.009	0.030	....
22	0.08	0.38	0.010	0.034	0.009	0.029	....
23	0.10	0.38	0.004	0.029	0.009	0.028	....
24	0.09	0.38	0.004	0.030	0.009	0.031	....
25	0.10	0.38	0.011	0.028	0.009	0.029	....
26	0.10	0.38	0.006	0.028	0.009	0.030	....
27	0.10	0.38	0.005	0.028	0.009	0.029	....
28	0.12	0.38	0.010	0.028	0.006	0.020	trace
29	0.12	0.38	0.006	0.027	0.006	0.024	trace
30	0.12	0.37	0.006	0.027	0.005	0.032	trace
31	0.11	0.37	0.008	0.025	0.005	0.028	trace
32	0.11	0.38	0.006	0.026	0.005	0.028	trace
33	0.11	0.38	0.012	0.027	0.005	0.028	trace
34	0.14	0.38	0.012	0.027	0.005	0.036	trace
35	0.12	0.38	0.012	0.027	0.005	0.028	trace
36	0.11	0.38	0.010	0.026	0.005	0.032	trace

ANALYSIS OF STEEL SHEETS, SERIES "B."

TABLE I.—NO. 22 GAGE OPEN-HEARTH STEEL.
(ALAN WOOD IRON AND STEEL CO.)
SERIES B. MARKED *M*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.08	0.36	0.010	0.045	....	0.19	0.03
2	0.08	0.39	0.010	0.042	0.020	0.21	0.04
3	0.09	0.39	0.010	0.043	....	0.21	0.035
4	0.09	0.37	0.009	0.042	....	0.18	0.025
5	0.08	0.42	0.008	0.041	....	0.19	0.020
6	0.08	0.43	0.011	0.039	0.018	0.19	0.045
7	0.11	0.53	0.022	0.035	0.014	0.183	0.031
8	0.105	0.35	0.015	0.033	0.003	0.22	0.031
9	0.12	0.33	0.008	0.050	0.018	0.17	0.04
10	0.13	0.32	0.017	0.053	0.018	0.18	0.04
11	0.12	0.37	0.007	0.033	....	0.198	0.047
12	0.12	0.37	0.012	0.038	0.009	0.224	0.050
13	0.062	0.355	0.017	0.049	0.005	0.190	0.067
14	0.11	0.43	0.016	0.038	0.008	0.191	none
15	0.065	0.35	0.016	0.036	....	0.111	....
16	0.13	0.57	0.020	0.038	....	0.184	....
17	0.077	0.35	0.012	0.044	....	0.18	....
18	0.077	0.38	0.017	0.048	....	0.18	....
19	0.092	0.57	0.025	0.042	....	0.176	....
20	0.075	0.37	0.015	0.042	0.014	....	none
21	0.099	0.58	0.019	0.041	0.023	0.176	none
22	0.077	0.35	0.014	0.042	....	0.180	....
23	0.072	0.44	0.013	0.042	....	0.180	....
24	0.105	0.561	0.020	0.039	....	0.179	0.039
25	0.085	0.434	0.017	0.037	....	0.180	0.038
26	0.08	0.351	0.013	0.037	....	0.189	0.041
27	0.094	0.331	0.014	0.041	0.015	0.173	0.040
28	0.091	0.36	0.014	0.040	....	0.184	0.036
29	0.095	0.36	0.013	0.041	....	0.176	0.038
30	0.10	0.32	0.007	0.045	0.011	0.176	none
31	0.11	0.52	0.005	0.047	....	0.178	none
32	0.10	0.52	0.007	0.051	....	0.16	none
33	0.10	0.52	0.006	0.034	0.013	0.176	none
34	0.09	0.43	0.006	0.044	....	0.178	none
35	0.10	0.43	0.006	0.046	....	0.172	none
36	0.10	0.52	0.007	0.042	....	0.168	none
37	0.10	0.59	0.019	0.038	0.011	0.21	none
38	0.085	0.39	0.015	0.036	0.005	0.23	none
39	0.095	0.61	0.025	0.039	0.005	0.19	none
40	0.06	0.39	0.015	0.035	0.009	0.19	none
41	0.075	0.40	0.017	0.040	0.005	0.20	none
42	0.085	0.42	0.015	0.040	0.006	0.20	none

TABLE II.—No. 16 GAGE OPEN-HEARTH STEEL.
(ALAN WOOD IRON AND STEEL CO.)
SERIES B. MARKED *MM*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.10	0.46	0.008	0.029	....	0.06	0.045
2	0.10	0.46	0.007	0.029	0.018	0.06	0.05
3	0.12	0.55	0.008	0.024	....	0.06	0.04
4	0.10	0.47	0.008	0.022	....	0.06	0.03
5	0.09	0.48	0.008	0.028	....	0.06	0.025
6	0.11	0.44	0.009	0.029	0.020	0.05	0.035
7	0.11	0.38	0.012	0.025	0.015	0.057	0.054
8	0.13	0.39	0.011	0.023	none	0.06	0.054
9	0.12	0.38	0.007	0.023	0.004	0.063	0.054
10	0.13	0.34	0.009	0.023	0.006	0.05	0.04
11	0.13	0.40	0.010	0.032	0.006	0.05	0.04
12	0.134	0.37	0.011	0.022	0.006	0.06	0.04
13	0.13	0.40	0.006	0.028	....	0.09	0.039
14	0.12	0.40	0.007	0.029	....	0.09	0.035
15	0.12	0.40	0.006	0.025	0.009	0.088	0.043
16	0.071	0.399	0.017	0.034	0.004	0.057	0.071
17	0.115	0.39	0.014	0.028	none	0.048	none
18	0.111	0.40	0.014	0.029	....	0.038	....
19	0.121	0.40	0.014	0.023	....	0.057	....
20	0.097	0.39	0.011	0.030	....	0.048	....
21	0.105	0.40	0.012	0.028	0.014	0.048	none
22	0.105	0.40	0.011	0.029	....	0.052	....
23	0.105	0.41	0.011	0.030	....	0.044	....
24	0.10	0.40	0.011	0.032	....	0.048	....
25	0.10	0.39	0.014	0.029	....	0.048	....
26	0.117	0.388	0.010	0.028	0.002	0.066	0.032
27	0.117	0.396	0.011	0.029	....	0.059	0.038
28	0.112	0.39	0.011	0.027	....	0.061	0.034
29	0.113	0.386	0.012	0.032	....	0.059	0.035
30	0.115	0.391	0.011	0.028	....	0.066	0.036
31	0.11	0.40	0.006	0.035	0.004	0.042	none
32	0.10	0.40	0.005	0.036	....	0.04	none
33	0.10	0.40	0.003	0.035	....	0.04	none
34	0.10	0.40	0.005	0.031	0.004	0.02	none
35	0.10	0.44	0.015	0.032	0.006	0.055	none
36	0.085	0.45	0.012	0.030	0.005	0.055	none
37	0.11	0.46	0.011	0.031	0.004	0.045	none
38	0.06	0.45	0.009	0.030	0.005	0.055	none
39	0.105	0.42	0.011	0.031	0.005	0.050	none
40	0.105	0.44	0.011	0.029	0.005	0.055	none
41	0.115	0.42	0.012	0.032	0.005	0.08	none
42	0.075	0.44	0.013	0.034	0.005	0.05	none

TABLE III.—No. 22 GAGE ARMCO IRON.
(AMERICAN ROLLING MILL CO.)
SERIES B. MARKED *S*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	none	0.007	0.024	....	0.027	none
2	trace	none	0.006	0.018	0.013	0.027	none
3	trace	none	0.005	0.019	....	0.024	none
4	trace	none	0.005	0.017	....	0.021	none
5	trace	none	0.004	0.020	....	0.024	none
6	trace	none	0.005	0.022	0.012	0.021	none
7	0.020	0.03	0.002	0.018	0.002	0.031	0.015
8	0.025	0.07	0.006	0.017	0.003	0.025	0.015
9	0.025	0.06	0.011	0.016	....	0.025	0.015
10	0.02	0.01	0.011	0.029	0.003	0.02	none
11	0.02	0.01	0.003	0.033	0.003	0.02	none
12	0.02	0.01	0.003	0.028	0.003	0.02	none
13	0.03	0.04	0.003	0.014	....	0.042	0.027
14	0.03	0.03	0.004	0.015	....	0.054	0.027
15	0.03	0.03	0.003	0.015	0.006	0.056	0.031
16	0.014	0.016	0.011	0.018	none	0.029	0.049
17	0.008	0.016	0.010	0.019	none	0.028	0.087
18	0.01	0.05	0.004	0.017	none	0.035	none
19	0.014	0.04	0.006	0.017	....	0.037	....
20	0.011	0.04	0.006	0.017	....	0.029	....
21	0.015	0.015	0.007	0.024	....	0.02	....
22	0.015	0.02	0.006	0.022	....	0.02	....
23	0.015	0.02	0.007	0.024	0.003	0.016	none
24	0.014	0.01	0.009	0.025	....	0.012	....
25	0.014	0.015	0.010	0.026	....	0.02	....
26	0.015	0.015	0.007	0.024	....	0.02	....
27	0.019	0.013	0.005	0.018	....	0.019	trace
28	0.017	0.011	0.005	0.018	0.002	0.017	trace
29	0.018	0.013	0.005	0.019	....	0.021	trace
30	0.02	0.011	0.005	0.018	....	0.026	trace
31	0.019	0.012	0.005	0.018	....	0.030	trace
32	0.02	0.018	0.005	0.029	0.001	0.016	none
33	0.02	0.018	0.003	0.028	....	0.01	none
34	0.02	0.018	0.004	0.028	....	0.01	none
35	0.02	0.018	0.003	0.024	0.001	0.006	none
36	0.015	0.02	0.006	0.022	0.005	0.003	none
37	0.015	0.02	0.004	0.027	0.006	0.024	none
38	0.025	0.02	0.006	0.029	0.005	0.03	none
39	0.015	0.02	0.005	0.027	0.005	0.024	none
40	0.01	0.02	0.004	0.029	0.005	0.04	none
41	0.01	0.02	0.005	0.030	0.004	0.03	none
42	0.02	0.02	0.006	0.026	trace	0.03	none

TABLE IV.—NO. 16 GAGE ARMCO IRON.
(AMERICAN ROLLING MILL CO.)
SERIES B. MARKED *SS*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	none	0.005	0.023	0.014	0.032	none
2	trace	none	0.006	0.021	....	0.029	none
3	trace	none	0.004	0.020	....	0.021	none
4	trace	none	0.006	0.018	....	0.024	none
5	trace	none	0.004	0.020	....	0.032	none
6	trace	none	0.005	0.020	0.012	0.021	none
7	0.02	0.03	0.006	0.012	0.004	0.018	0.023
8	0.02	0.04	0.007	0.014	0.004	0.022	0.023
9	0.018	0.01	0.007	0.025	0.003	0.02	none
10	0.02	0.01	0.007	0.032	0.003	0.02	none
11	0.02	0.01	0.006	0.030	0.003	0.014	none
12	0.03	0.04	0.004	0.012	....	0.048	0.027
13	0.03	0.03	0.003	0.015	....	0.054	0.031
14	0.03	0.04	0.003	0.015	0.006	0.046	0.031
15	0.008	0.016	0.010	0.019	none	0.025	0.045
16	0.012	0.016	0.010	0.018	0.005	0.024	0.039
17	0.010	0.04	0.008	0.017	none	0.027	none
18	0.009	0.04	0.006	0.017	....	0.022	....
19	0.011	0.02	0.006	0.019	....	0.024	....
20	0.015	0.015	0.008	0.021	0.014	0.020	....
21	0.015	0.02	0.008	0.022	....	0.016	....
22	0.015	0.02	0.007	0.018	....	0.016	....
23	0.014	0.02	0.009	0.022	....	0.016	....
24	0.015	0.015	0.007	0.022	....	0.02	....
25	0.014	0.015	0.006	0.022	....	0.02	....
26	0.024	0.011	0.005	0.018	....	0.026	trace
27	0.023	0.012	0.005	0.017	....	0.024	trace
28	0.017	0.012	0.005	0.018	....	0.026	trace
29	0.021	0.013	0.005	0.018	....	0.026	trace
30	0.018	0.011	0.005	0.019	0.006	0.019	trace
31	0.02	0.018	0.004	0.023	0.003	0.014	none
32	0.02	0.018	0.003	0.026	....	0.024	none
33	0.02	0.018	0.003	0.029	....	0.012	none
34	0.02	0.018	0.004	0.023	0.002	0.010	none
35	0.02	0.02	0.007	0.028	trace	0.03	none
36	0.005	0.02	0.005	0.025	trace	0.022	none
37	0.005	0.02	0.006	0.029	trace	0.03	none
38	0.015	0.02	0.008	0.027	trace	0.03	none
39	0.01	0.02	0.005	0.025	trace	0.03	none
40	0.01	0.02	0.006	0.025	trace	0.03	none
41	0.03	0.02	0.007	0.022	trace	0.024	none
42	0.015	0.02	0.007	0.022	trace	0.03	none

TABLE V.—NO. 22 GAGE KENTUCKY COPPER STEEL.
(NEWPORT ROLLING MILL CO.)
SERIES B. MARKED *T*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.07	0.38	0.008	0.019	....	0.28	none
2	0.08	0.31	0.007	0.020	0.010	0.22	none
3	0.09	0.35	0.007	0.018	....	0.22	none
4	0.07	0.32	0.009	0.020	....	0.22	none
5	0.07	0.35	0.008	0.025	....	0.22	none
6	0.09	0.35	0.008	0.020	0.011	0.22	none
7	0.08	0.32	0.006	0.013	....	0.242	none
8	0.10	0.32	0.010	0.013	0.002	0.249	none
9	0.08	0.30	0.010	0.009	0.002	0.234	none
10	0.085	0.28	0.006	0.021	none	0.19	0.03
11	0.08	0.25	0.010	0.019	none	0.18	0.03
12	0.08	0.30	0.010	0.023	none	0.22	0.03
13	0.08	0.31	0.009	0.017	....	0.271	....
14	0.09	0.32	0.007	0.015	....	0.281	....
15	0.09	0.32	0.006	0.015	0.005	0.275	none
16	0.061	0.312	0.012	0.016	0.005	0.174	0.014
17	0.062	0.29	0.015	0.016	none	0.262	none
18	0.078	0.30	0.010	0.015	0.007	0.244	none
19	0.094	0.32	0.010	0.018	....	0.241	....
20	0.086	0.31	0.010	0.018	....	0.239	....
21	0.084	0.31	0.013	0.024	....	0.24	....
22	0.08	0.31	0.012	0.022	....	0.24	....
23	0.084	0.31	0.011	0.022	0.005	0.24	none
24	0.08	0.30	0.011	0.018	....	0.224	....
25	0.083	0.32	0.013	0.024	....	0.24	....
26	0.078	0.30	0.009	0.020	....	0.232	....
27	0.0[illegible]3	0.291	0.007	0.017	....	0.221	none
28	0.089	0.315	0.009	0.019	....	0.225	none
29	0.085	0.294	0.007	0.018	0.009	0.216	none
30	0.103	0.305	0.010	0.019	....	0.219	none
31	0.091	0.299	0.009	0.019	....	0.209	none
32	0.10	0.32	0.006	0.025	0.001	0.226	none
33	0.10	0.32	0.006	0.022	....	0.228	none
34	0.10	0.34	0.006	0.024	....	0.212	none
35	0.10	0.34	0.006	0.022	0.003	0.226	none
36	0.08	0.30	0.009	0.023	trace	0.21	none
37	0.07	0.30	0.009	0.021	trace	0.23	none
38	0.07	0.32	0.010	0.024	trace	0.21	none
39	0.075	0.32	0.008	0.024	trace	0.19	none
40	0.085	0.31	0.009	0.025	trace	0.20	none
41	0.09	0.31	0.009	0.023	trace	0.20	none
42	0.085	0.31	0.008	0.024	trace	0.23	none

TABLE VI.—NO. 16 GAGE KENTUCKY COPPER STEEL.
(NEWPORT ROLLING MILL CO.)
SERIES B. MARKED *TT*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.08	0.37	0.009	0.024	....	0.24	none
2	0.07	0.36	0.008	0.023	0.018	0.22	none
3	0.07	0.41	0.008	0.018	....	0.21	none
4	0.07	0.38	0.006	0.018	....	0.22	none
5	0.07	0.38	0.007	0.020	....	0.21	none
6	0.08	0.38	0.007	0.019	0.019	0.21	none
7	0.095	0.30	0.011	0.011	0.003	0.24	none
8	0.095	0.30	0.010	0.011	....	0.244	none
9	0.11	0.30	0.009	0.011	0.005	0.24	none
10	0.075	0.25	0.012	0.020	none	0.20	0.03
11	0.08	0.27	0.005	0.023	none	0.16	0.03
12	0.085	0.27	0.007	0.028	none	0.18	0.03
13	0.09	0.33	0.008	0.017	....	0.279	....
14	0.09	0.33	0.007	0.016	....	0.279	....
15	0.09	0.33	0.013	0.016	0.005	0.279	....
16	0.077	0.312	0.012	0.018	0.004	0.213	none
17	0.062	0.312	0.013	0.019	0.006	0.173	none
18	0.093	0.31	0.010	0.017	none	0.242	none
19	0.074	0.31	0.008	0.017	....	0.239	....
20	0.07	0.30	0.008	0.014	....	0.257	....
21	0.078	0.30	0.014	0.023	....	0.24	....
22	0.078	0.30	0.016	0.022	....	0.24	....
23	0.075	0.30	0.009	0.019	....	0.232	....
24	0.078	0.31	0.011	0.018	0.023	0.24	none
25	0.075	0.31	0.015	0.025	....	0.24	....
26	0.075	0.31	0.012	0.023	....	0.236	....
27	0.073	0.283	0.009	0.018	....	0.219	none
28	0.079	0.30	0.008	0.019	....	0.229	none
29	0.078	0.289	0.008	0.012	....	0.211	none
30	0.086	0.285	0.008	0.018	....	0.214	none
31	0.078	0.299	0.009	0.019	0.002	0.214	none
32	0.09	0.31	0.006	0.024	0.002	0.216	none
33	0.09	0.29	0.005	0.022	....	0.208	none
34	0.09	0.29	0.005	0.021	....	0.194	none
35	0.09	0.29	0.005	0.024	0.002	0.226	none
36	0.08	0.30	0.010	0.025	trace	0.21	none
37	0.085	0.30	0.010	0.025	trace	0.19	none
38	0.065	0.30	0.009	0.023	trace	0.21	none
39	0.065	0.31	0.008	0.024	trace	0.21	none
40	0.07	0.31	0.009	0.019	trace	0.23	none
41	0.095	0.33	0.010	0.029	trace	0.21	none
42	0.075	0.34	0.009	0.020	trace	0.23	none

TABLE VII.—No. 22 GAGE ALLEGHENY IRON.
(ALLEGHENY STEEL CO.)
SERIES B. MARKED *U*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	0.10	0.007	0.034	....	0.26	0.02
2	trace	0.09	0.008	0.035	0.010	0.22	0.02
3	trace	0.09	0.008	0.039	....	0.23	0.035
4	trace	0.09	0.009	0.036	....	0.23	0.030
5	trace	0.10	0.009	0.038	0.011	0.23	0.025
6	0.025	0.09	0.008	0.041	0.006	0.291	0.035
7	0.035	0.07	0.008	0.033	....	0.278	0.035
8	0.025	0.10	0.010	0.032	0.007	0.27	0.035
9	0.025	0.08	0.006	0.031	....	0.277	0.035
10	0.03	0.09	0.007	0.037	0.003	0.281	0.035
11	0.02	0.07	0.005	0.046	none	0.23	0.02
12	0.02	0.06	0.007	0.043	none	0.21	0.02
13	0.02	0.06	0.010	0.050	none	0.27	0.02
14	0.02	0.06	0.009	0.050	none	0.21	0.02
15	0.03	0.05	0.013	0.050	none	0.25	0.02
16	0.02	0.07	0.007	0.029	....	0.291	0.035
17	0.02	0.09	0.007	0.032	....	0.289	0.027
18	0.02	0.08	0.006	0.036	....	0.283	0.02[illegible]
19	0.02	0.10	0.005	0.031	....	0.289	0.031
20	0.02	0.10	0.007	0.031	0.006	0.297	0.035
21	0.011	0.068	0.009	0.027	0.009	0.261	0.114
22	0.015	0.06	0.010	0.035	none	0.223	none
23	0.015	0.07	0.010	0.036	....	0.263	....
24	0.012	0.06	0.010	0.039	....	0.257	....
25	0.018	0.06	0.010	0.033	....	0.274	....
26	0.015	0.06	0.010	0.033	....	0.257	....
27	0.006	0.08	0.012	0.039	0.003	0.26	none
28	0.006	0.07	0.009	0.037	....	0.26	....
29	0.006	0.06	0.013	0.048	....	0.26	....
30	0.012	0.066	0.008	0.037	....	0.257	0.011
31	0.013	0.066	0.007	0.039	0.002	0.268	0.010
32	0.014	0.066	0.007	0.034	....	0.249	0.015
33	0.014	0.066	0.007	0.035	....	0.262	0.013
34	0.02	0.063	0.007	0.036	0.002	0.25	none
35	0.02	0.063	0.007	0.036	....	0.210	none
36	0.02	0.072	0.007	0.048	0.001	0.246	none
37	0.04	0.12	0.004	0.040	trace	0.28	none
38	0.01	0.07	0.007	0.035	trace	0.28	none
39	0.005	0.08	0.006	0.034	trace	0.27	none
40	0.01	0.07	0.007	0.040	trace	0.27	none
41	0.005	0.07	0.008	0.037	trace	0.28	none
42	0.01	0.07	0.008	0.036	trace	0.28	none

TABLE VIII.—NO. 16 GAGE ALLEGHENY IRON.
(ALLEGHENY STEEL CO.)
SERIES B. MARKED *UU*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	0.10	0.006	0.032	....	0.24	none
2	trace	0.12	0.007	0.028	0.009	0.22	none
3	trace	0.08	0.007	0.030	0.010	0.21	none
4	0.025	0.08	0.006	0.018	0.007	0.28	none
5	0.030	0.04	0.005	0.018	....	0.263	none
6	0.04	0.07	0.006	0.018	0.007	0.275	none
7	0.022	0.05	0.005	0.037	0.004	0.24	0.02
8	0.025	0.05	0.006	0.038	0.004	0.24	0.02
9	0.02	0.06	0.007	0.024	0.004	0.18	0.02
10	0.02	0.07	0.007	0.024	....	0.265	0.047
11	0.02	0.07	0.004	0.024	....	0.269	0.039
12	0.02	0.07	0.006	0.024	0.006	0.267	0.031
13	0.016	0.068	0.006	0.027	0.005	0.258	0.049
14	0.018	0.064	0.009	0.029	0.008	0.186	0.022
15	0.014	0.064	0.007	0.028	0.010	0.235	0.028
16	0.025	0.06	0.010	0.022	none	0.235	none
17	0.014	0.06	0.010	0.022	....	0.227	....
18	0.010	0.06	0.008	0.024	....	0.236	....
19	0.014	0.07	0.009	0.030	....	0.244	....
20	0.012	0.06	0.011	0.028	....	0.240	....
21	0.012	0.06	0.012	0.031	0.009	0.240	none
22	0.014	0.06	0.010	0.029	....	0.24	....
23	0.012	0.07	0.008	0.034	....	0.24	....
24	0.012	0.07	0.009	0.033	....	0.236	....
25	0.020	0.062	0.006	0.026	....	0.233	0.010
26	0.022	0.061	0.006	0.027	....	0.24	0.009
27	0.018	0.062	0.006	0.022	....	0.233	0.011
28	0.022	0.063	0.006	0.026	....	0.235	0.013
29	0.022	0.063	0.006	0.023	0.002	0.243	0.007
30	0.018	0.062	0.005	0.023	....	0.23	0.011
31	0.02	0.054	0.005	0.032	0.002	0.214	none
32	0.02	0.054	0.004	0.036	....	0.226	none
33	0.02	0.054	0.003	0.032	....	0.206	none
34	0.02	0.054	0.005	0.031	0.002	0.224	none
35	0.02	0.072	0.003	0.031	....	0.216	none
36	0.02	0.072	0.004	0.030	....	0.218	none
37	0.005	0.07	0.012	0.030	trace	0.27	none
38	0.01	0.07	0.006	0.032	trace	0.27	none
39	0.01	0.07	0.018	0.032	trace	0.27	none
40	0.01	0.07	0.022	0.035	trace	0.27	none
41	0.015	0.08	0.010	0.035	trace	0.27	none
42	0.020	0.07	0.009	0.032	trace	0.21	none

TABLE IX.—NO. 22 GAGE PORTSMOUTH IRON.
(WHITAKER GLESSNER CO.)
SERIES B. MARKED *V*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	0.10	0.007	0.028	....	0.31	none
2	trace	0.10	0.008	0.024	0.011	0.28	none
3	trace	0.09	0.008	0.030	....	0.28	none
4	trace	0.08	0.008	0.027	....	0.28	none
5	trace	0.07	0.008	0.026	....	0.28	none
6	trace	0.09	0.009	0.023	0.010	0.28	none
7	0.025	0.056	0.003	0.013	....	0.328	none
8	0.025	0.056	0.003	0.014	....	0.334	none
9	0.025	0.06	0.004	0.011	....	0.347	none
10	0.025	0.04	0.005	0.019	none	0.33	0.02
11	0.025	0.03	0.005	0.020	none	0.32	0.02
12	0.025	0.04	0.007	0.025	none	0.33	0.02
13	0.02	0.06	0.004	0.014	0.006	0.34	....
14	0.02	0.07	0.006	0.014	....	0.339	....
15	0.02	0.05	0.005	0.014	....	0.331	none
16	0.008	0.04	0.006	0.018	0.008	0.278	none
17	0.008	0.037	0.009	0.018	0.008	0.26	none
18	0.015	0.04	0.012	0.017	none	0.303	none
19	0.016	0.03	0.010	0.015	....	0.269	....
20	0.020	0.04	0.012	0.017	....	0.29	....
21	0.012	0.04	0.007	0.022	....	0.308	....
22	0.012	0.03	0.007	0.019	0.009	0.308	none
23	0.011	0.04	0.007	0.023	....	0.304	....
24	0.011	0.05	0.007	0.024	....	0.308	....
25	0.012	0.04	0.007	0.023	....	0.30	....
26	0.012	0.04	0.010	0.024	....	0.308	....
27	0.02	0.037	0.006	0.018	....	0.288	none
28	0.022	0.035	0.006	0.017	0.002	0.305	none
29	0.021	0.036	0.006	0.017	....	0.312	none
30	0.02	0.036	0.005	0.016	....	0.296	none
31	0.02	0.036	0.006	0.017	....	0.308	none
32	0.02	0.036	0.006	0.024	0.002	0.269	none
33	0.02	0.036	0.005	0.026	....	0.296	none
34	0.02	0.036	0.004	0.027	....	0.286	none
35	0.02	0.036	0.004	0.022	0.002	0.285	none
36	0.01	0.06	0.008	0.023	trace	0.33	none
37	0.01	0.05	0.007	0.023	trace	0.31	none
38	0.025	0.05	0.007	0.024	trace	0.31	none
39	0.01	0.05	0.006	0.024	trace	0.31	none
40	0.01	0.05	0.007	0.025	trace	0.31	none
41	0.02	0.06	0.007	0.019	trace	0.28	none
42	0.02	0.08	0.007	0.021	trace	0.31	none

TABLE X.—NO. 16 GAGE PORTSMOUTH IRON.
(WHITAKER GLESSNER CO.)
SERIES B. MARKED *VV*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	0.09	0.009	0.027	....	0.32	none
2	trace	0.10	0.009	0.023	0.012	0.29	none
3	trace	0.10	0.008	0.020	....	0.28	none
4	trace	0.09	0.008	0.023	....	0.27	none
5	trace	0.08	0.007	0.021	....	0.27	none
6	trace	0.10	0.008	0.019	0.014	0.27	none
7	0.02	0.06	0.005	0.010	....	0.309	none
8	0.025	0.05	0.007	0.014	....	0.337	none
9	0.025	0.05	0.006	0.015	0.005	0.339	none
10	0.025	0.05	0.008	0.012	....	0.34	none
11	0.035	0.05	0.005	0.013	....	0.324	none
12	0.025	0.05	0.007	0.009	0.005	0.32	none
13	0.025	0.03	0.006	0.02	none	0.27	0.02
14	0.025	0.04	0.007	0.022	none	0.30	0.02
15	0.025	0.04	0.008	0.025	none	0.33	0.02
16	0.025	0.03	0.006	0.022	none	0.25	0.02
17	0.025	0.03	0.006	0.020	none	0.30	0.02
18	0.025	0.03	0.006	0.030	none	0.30	0.02
19	0.04	0.05	0.004	0.017	....	0.358	none
20	0.04	0.05	0.006	0.017	....	0.384	....
21	0.04	0.06	0.006	0.015	....	0.369	....
22	0.04	0.06	0.003	0.022	0.005	0.379	....
23	0.04	0.06	0.004	0.015	....	0.341	....
24	0.04	0.05	0.004	0.018	....	0.339	....
25	0.012	0.04	0.005	0.019	0.003	0.308	0.032
26	0.013	0.037	0.004	0.018	none	0.318	0.022
27	0.007	0.04	0.005	0.019	none	0.286	none
28	0.014	0.02	0.010	0.014	none	0.30	none
29	0.015	0.03	0.010	0.015	....	0.306	....
30	0.014	0.03	0.008	0.014	....	0.266	....
31	0.012	0.04	0.008	0.015	....	0.268	....
32	0.013	0.04	0.008	0.015	....	0.267	....
33	0.011	0.04	0.006	0.016	....	0.265	....
34	0.009	0.05	0.009	0.017	....	0.30	....
35	0.008	0.04	0.008	0.022	....	0.304	....
36	0.009	0.04	0.009	0.021	0.033	0.304	none
37	0.009	0.04	0.008	0.023	....	0.308	....
38	0.009	0.04	0.008	0.017	....	0.304	....
39	0.009	0.04	0.009	0.019	....	0.308	....
40	0.019	0.037	0.006	0.019	....	0.302	none
41	0.018	0.037	0.005	0.018	0.002	0.300	none
42	0.017	0.036	0.007	0.019	....	0.304	none
43	0.019	0.037	0.006	0.020	....	0.316	none
44	0.016	0.036	0.006	0.018	....	0.291	none
45	0.016	0.037	0.007	0.019	....	0.307	none
46	0.02	0.018	0.004	0.024	0.002	0.266	none
47	0.02	0.018	0.005	0.026	....	0.282	none
48	0.02	0.018	0.005	0.024	....	0.24	none
49	0.02	0.018	0.005	0.024	....	0.264	none
50	0.02	0.018	0.004	0.023	....	0.224	none
51	0.02	0.018	0.005	0.023	0.001	0.274	none
52	0.03	0.06	0.008	0.020	trace	0.30	none
53	0.02	0.05	0.007	0.020	trace	0.29	none
54	0.01	0.05	0.008	0.022	trace	0.27	none
55	0.005	0.06	0.008	0.017	trace	0.28	none
56	0.025	0.06	0.009	0.023	trace	0.25	none
57	0.015	0.06	0.008	0.020	trace	0.30	none

TABLE XI.—NO. 22 GAGE VISMERA.
(INLAND STEEL CO.)
SERIES B. MARKED *X*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	trace	0.07	0.007	0.026	....	0.048	none
2	trace	0.10	0.006	0.030	0.010	0.043	none
3	trace	0.08	0.007	0.032	....	0.032	none
4	trace	0.07	0.007	0.029	....	0.033	none
5	trace	0.10	0.008	0.024	....	0.037	none
6	trace	0.09	0.008	0.028	0.011	0.032	none
7	0.02	0.07	0.002	0.020	0.002	0.024	none
8	0.02	0.05	0.004	0.020	0.006	0.030	none
9	0.025	0.04	0.004	0.046	none	0.02	none
10	0.025	0.04	0.009	0.034	none	0.04	none
11	0.025	0.04	0.009	0.060	none	0.03	none
12	0.02	0.05	0.006	0.024	....	0.058	....
13	0.02	0.05	0.005	0.022	....	0.062	....
14	0.02	0.05	0.005	0.025	0.006	0.05	none
15	0.014	0.042	0.008	0.036	0.002	0.021	0.043
16	0.015	0.04	0.006	0.022	none	0.024	none
17	0.018	0.04	0.006	0.026	....	0.024	....
18	0.018	0.04	0.006	0.023	....	0.024	....
19	0.024	0.05	0.010	0.033	0.009	0.024	none
20	0.023	0.04	0.010	0.042	....	0.028	....
21	0.023	0.03	0.009	0.038	....	0.024	....
22	0.023	0.04	0.007	0.036	....	0.024	....
23	0.015	0.09	0.009	0.035	....	0.020	....
24	0.024	0.04	0.009	0.036	....	0.024	....
25	0.021	0.04	0.005	0.027	0.002	0.009	none
26	0.015	0.038	0.005	0.031	....	0.009	none
27	0.015	0.037	0.005	0.027	....	0.009	none
28	0.021	0.039	0.005	0.027	....	0.009	none
29	0.023	0.038	0.005	0.029	....	0.014	none
30	0.018	0.038	0.005	0.028	....	0.016	none
31	0.02	0.054	0.004	0.031	0.002	0.020	none
32	0.02	0.054	0.004	0.035	....	0.030	none
33	0.02	0.054	0.005	0.030	....	0.020	none
34	0.02	0.054	0.003	0.031	0.002	0.022	none
35	0.01	0.08	0.009	0.031	trace	0.01	none
36	0.02	0.05	0.007	0.029	trace	0.025	none
37	0.025	0.08	0.010	0.025	trace	0.015	none
38	0.02	0.07	0.008	0.030	trace	0.025	none
39	0.005	0.06	0.008	0.029	trace	0.025	none
40	0.035	0.06	0.007	0.032	trace	0.025	none
41	0.03	0.06	0.007	0.036	trace	0.025	none
42	0.03	0.05	0.008	0.031	trace	0.025	none

TABLE XII.—NO. 16 GAGE VISMERA.
(INLAND STEEL CO.)
SERIS B. MARKED *XX*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.03	0.09	0.010	0.034	....	0.03	none
2	0.03	0.09	0.010	0.032	0.008	0.04	none
3	0.04	0.08	0.011	0.028	....	0.04	none
4	0.03	0.14	0.010	0.028	....	0.037	none
5	0.03	0.09	0.009	0.027	....	0.032	none
6	0.03	0.07	0.009	0.032	0.007	0.036	none
7	0.03	0.07	0.009	0.022	0.006	0.03	none
8	0.03	0.06	0.007	0.016	0.008	0.031	none
9	0.03	0.06	0.009	0.021	....	0.029	none
10	0.028	0.04	0.009	0.037	0.005	0.02	none
11	0.025	0.05	0.012	0.031	0.005	0.02	none
12	0.025	0.05	0.006	0.036	0.005	0.03	none
13	0.03	0.06	0.008	0.024	....	0.064	....
14	0.03	0.06	0.008	0.023	....	0.066	....
15	0.03	0.06	0.006	0.025	0.005	0.066	....
16	0.015	0.048	0.008	0.036	0.003	0.027	0.022
17	0.015	0.04	0.006	0.023	none	0.024	none
18	0.012	0.04	0.006	0.023	....	0.024	....
19	0.014	0.05	0.006	0.025	....	0.031	....
20	0.015	0.05	0.011	0.031	....	0.028	....
21	0.016	0.06	0.014	0.036	....	0.024	....
22	0.015	0.06	0.011	0.035	....	0.028	....
23	0.015	0.05	0.011	0.037	0.009	0.024	none
24	0.015	0.06	0.013	0.036	....	0.02	....
25	0.014	0.06	0.013	0.037	....	0.024	....
26	0.014	0.053	0.008	0.030	0.002	0.014	none
27	0.015	0.052	0.008	0.030	....	0.012	none
28	0.022	0.051	0.010	0.032	....	0.014	none
29	0.016	0.052	0.008	0.031	....	0.018	none
30	0.019	0.052	0.008	0.031	....	0.013	none
31	0.02	0.072	0.006	0.035	0.002	0.024	none
32	0.02	0.072	0.006	0.036	....	0.024	none
33	0.02	0.072	0.006	0.034	....	0.020	none
34	0.02	0.072	0.003	0.028	0.002	0.03	none
35	0.02	0.07	0.008	0.029	trace	0.04	none
36	0.02	0.07	0.006	0.032	trace	0.03	none
37	0.01	0.08	0.007	0.035	trace	0.03	none
38	0.025	0.06	0.009	0.035	trace	0.03	none
39	0.01	0.07	0.004	0.027	trace	0.03	none
40	0.02	0.06	0.004	0.026	trace	0.025	none
41	0.015	0.06	0.006	0.041	trace	0.025	none
42	0.020	0.08	0.006	0.031	trace	0.025	none

TABLE XIII.—NO. 22 GAGE LOW-COPPER WROUGHT IRON.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES B. MARKED *Y*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.03	0.05	0.147	0.021	0.21	0.020	....
2	0.03	0.06	0.155	0.021	0.23	0.020	....
3	0.03	0.05	0.147	0.021	0.22	0.020	....
4	0.03	0.06	0.133	0.020	0.19	0.020	....
5	0.03	0.05	0.143	0.020	0.20	0.020	....
6	0.03	0.04	0.148	0.020	0.23	0.016	....
7	0.03	0.06	0.153	0.021	0.20	0.020	....
8	0.03	0.06	0.155	0.019	0.23	0.024	....
9	0.03	0.07	0.160	0.021	0.25	0.024	....

NO. 16 GAGE LOW-COPPER WROUGHT IRON.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES B. MARKED *YY*.

1	0.03	0.06	0.137	0.019	0.24	0.024	....
2	0.03	0.04	0.114	0.019	0.19	0.020	....
3	0.03	0.05	0.108	0.019	0.21	0.024	....
4	0.03	0.06	0.119	0.021	0.19	0.024	....
5	0.03	0.04	0.135	0.018	0.19	0.020	....
6	0.03	0.05	0.131	0.018	0.23	0.020	....
7	0.03	0.06	0.111	0.018	0.19	0.024	....
8	0.03	0.05	0.130	0.018	0.20	0.024	....
9	0.03	0.05	0.122	0.018	0.19	0.024	....

TABLE XIV.—NO. 22 GAGE BESSEMER STEEL WITH VARYING COPPER CONTENT.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES B. MARKED *ZB*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.06	0.40	0.106	0.042	....	0.016	none
2	0.06	0.40	0.085	0.038	0.009	0.016	none
3	0.07	0.43	0.114	0.053	....	0.016	none
4	0.07	0.39	0.107	0.047	....	0.017	none
5	0.06	0.48	0.108	0.045	0.010	0.016	none
6	0.045	0.35	0.128	0.045	0.003	0.023	none
7	0.065	0.35	0.112	0.047	....	0.022	none
11	0.055	0.40	0.116	0.052	....	0.016	none
101	0.075	0.46	0.092	0.037	....	0.141	none
102	0.07	0.44	0.081	0.029	0.003	0.141	none
108	0.085	0.43	0.111	0.042	....	0.14	none
109	0.065	0.37	0.078	0.041	0.009	0.10	none
110	0.06	0.38	0.076	0.028	0.009	0.11	none
111	0.07	0.42	0.095	0.050	0.009	0.12	none
112	0.07	0.42	0.081	0.048	0.009	0.12	none
113	0.07	0.35	0.089	0.046	0.009	0.08	....
202	0.055	0.34	0.090	0.046	0.009	0.29	none
204	0.06	0.39	0.096	0.044	....	0.293	....
206	0.06	0.38	0.093	0.039	....	0.281	....
207	0.06	0.39	0.095	0.040	....	0.287	....
208	0.06	0.38	0.092	0.037	....	0.289	....
209	0.06	0.39	0.093	0.035	0.007	0.289	none
213	0.019	0.362	0.078	0.038	0.007	0.274	none
214	0.038	0.37	0.080	0.030	none	0.244	none
301	0.056	0.38	0.118	0.047	....	0.536	....
303	0.055	0.38	0.108	0.042	....	0.520	....
306	0.05	0.37	0.114	0.050	....	0.520	....
308	0.055	0.37	0.114	0.047	....	0.530	....
309	0.058	0.37	0.122	0.051	....	0.512	....
310	0.03	0.36	0.075	0.042	0.009	0.48	none
314	0.028	0.36	0.077	0.039	....	0.50	....

TABLE XV.—NO. 16 GAGE BESSEMER STEEL WITH VARYING COPPER CONTENT.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES B. MARKED *ZZB*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
1	0.07	0.45	0.063	0.026	....	0.014	none
2	0.09	0.42	0.071	0.029	0.008	0.016	none
4	0.08	0.41	0.107	0.039	....	0.021	none
5	0.08	0.48	0.103	0.043	....	0.024	none
7	0.08	0.42	0.102	0.034	....	0.023	none
8	0.08	0.41	0.110	0.045	....	0.024	none
10	0.07	0.46	0.106	0.040	0.008	0.019	none
14	0.07	0.33	0.074	0.026	....	0.010	none
102	0.11	0.41	0.111	0.046	....	0.229	none
103	0.115	0.415	0.107	0.044	....	0.172	none
106	0.08	0.40	0.091	0.035	0.006	0.154	none
107	0.08	0.40	0.092	0.037	0.004	0.146	none
201	0.07	0.34	0.082	0.032	....	0.294	none
202	0.075	0.34	0.088	0.033	....	0.298	none
204	0.095	0.34	0.104	0.043	....	0.325	none
205	0.08	0.32	0.084	0.040	none	0.14	none
206	0.08	0.36	0.105	0.035	none	0.24	none
208	0.10	0.31	0.102	0.060	none	0.20	none
209	0.085	0.30	0.087	0.045	none	0.23	none
213	0.08	0.31	0.077	0.035	none	0.30	none
306	0.07	0.31	0.087	0.040	none	0.33	none
307	0.075	0.30	0.091	0.050	none	0.47	none
308	0.07	0.35	0.083	0.032	....	0.511	....
309	0.06	0.36	0.082	0.035	....	0.503	....
310	0.06	0.37	0.085	0.035	....	0.529	....
311	0.07	0.37	0.080	0.031	....	0.51	....
314	0.07	0.35	0.090	0.034	....	0.58	....

TABLE XVI.—NO. 22 GAGE OPEN-HEARTH STEEL WITH VARYING COPPER CONTENT.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES B. MARKED *Z-O.H.*

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
417	0.037	0.32	0.067	0.046	....	0.016	....
418	0.030	0.31	0.060	0.040	....	0.012	....
419	0.028	0.32	0.063	0.041	....	0.016	....
420	0.032	0.33	0.060	0.041	....	0.016	....
421	0.092	0.317	0.070	0.044	....	0.024	none
422	0.090	0.315	0.068	0.043	....	0.019	none
423	0.105	0.313	0.070	0.045	....	0.016	none
424	0.11	0.328	0.068	0.043	0.002	0.018	none
501	0.06	0.342	0.050	0.053	0.003	0.145	none
503	0.07	0.358	0.044	0.054	....	0.184	none
504	0.072	0.352	0.042	0.049	....	0.185	none
506	0.06	0.36	0.045	0.053	....	0.168	none
508	0.06	0.36	0.052	0.064	....	0.218	none
509	0.06	0.36	0.044	0.051	....	0.160	none
513	0.06	0.34	0.047	0.057	....	0.266	none
516	0.06	0.34	0.056	0.070	....	0.224	none
602	0.06	0.32	0.049	0.068	....	0.262	none
603	0.06	0.32	0.047	0.056	0.003	0.232	none
604	0.075	0.40	0.054	0.053	trace	0.21	none
605	0.06	0.39	0.042	0.044	trace	0.28	none
606	0.055	0.38	0.052	0.050	trace	0.23	none
607	0.07	0.40	0.070	0.069	trace	0.30	none
608	0.07	0.38	0.046	0.044	trace	0.21	none
609	0.08	0.40	0.060	0.062	trace	0.25	none
702	0.08	0.43	0.057	0.059	trace	0.63	none
705	0.07	0.42	0.048	0.049	trace	0.60	none
707	0.07	0.41	0.051	0.054	trace	0.65	none
709	0.05	0.40	0.042	0.042	trace	0.47	none
710	0.08	0.39	0.042	0.041	trace	0.67	none
712	0.08	0.41	0.063	0.065	trace	0.54	none
714	0.06	0.41	0.037	0.039	trace	0.47	none
715	0.06	0.41	0.050	0.046	trace	0.47	none

TABLE XVII.—NO. 16 GAGE OPEN-HEARTH STEEL WITH VARYING COPPER CONTENT.
(YOUNGSTOWN SHEET AND TUBE CO.)
SERIES MARKED *ZZ-O.H.*

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
417	0.06	0.39	0.041	0.025	....	0.058	....
418	0.06	0.39	0.039	0.023	0.007	0.057	none
419	0.021	0.388	0.040	0.033	0.006	0.043	none
420	0.021	0.388	0.037	0.033	0.007	0.040	0.02
422	0.022	0.39	0.044	0.025	none	0.008	none
426	0.041	0.40	0.044	0.028	....	0.024	....
427	0.023	0.40	0.044	0.028	....	0.039	....
501	0.076	0.39	0.072	0.075	....	0.268	....
502	0.067	0.38	0.066	0.066	....	0.252	....
503	0.080	0.39	0.070	0.075	....	0.26	....
505	0.081	0.39	0.072	0.081	....	0.268	....
506	0.051	0.37	0.050	0.055	0.009	0.18	0.11
507	0.053	0.36	0.050	0.049	....	0.172	....
509	0.07	0.377	0.052	0.066	....	0.246	none
510	0.071	0.366	0.059	0.078	....	0.267	none
602	0.075	0.356	0.056	0.076	....	0.652	none
605	0.079	0.37	0.058	0.083	0.002	0.674	none
610	0.09	0.35	0.047	0.087	0.002	0.666	none
611	0.09	0.34	0.029	0.068	....	0.608	none
612	0.09	0.33	0.032	0.058	....	0.586	none
614	0.09	0.33	0.029	0.052	....	0.566	none
615	0.09	0.33	0.035	0.057	0.003	0.58	none
710	0.06	0.42	0.050	0.049	trace	0.31	none
711	0.06	0.42	0.050	0.047	trace	0.31	none
712	0.06	0.39	0.045	0.043	trace	0.31	none
713	0.06	0.39	0.053	0.045	trace	0.31	none
714	0.06	0.39	0.050	0.043	trace	0.31	none
715	0.08	0.40	0.061	0.053	trace	0.36	none

APPENDIX II.

REPORT OF SUB-COMMITTEE ON INSPECTION OF THE FORT SHERIDAN, PITTSBURGH AND ANNAPOLIS TESTS.

The Inspection Committee has held three meetings since its appointment on January 11, 1917.

The first meeting was held at Pittsburgh, Pa., on April 18, 1917, with Messrs. Buck, Cushman, Cooper, Fleming, McDonnell, Smith, Wheaton, Gibboney and Voorhees (*ex officio*) present, the representative of the Bureau of Steam Engineering of the U. S. Navy Department being absent.

At this meeting it was decided to hold semi-annual inspections of the field tests during the months of April and October.

The Pittsburgh sheets were examined on April 18, 1917, followed on April 19, 1917, by the Annapolis sheets. While certain peculiarities indicating differences between the conditions of the sheets at both locations were noted and recorded, it was decided that in view of the short period of exposure, about 5 months, and of the variations in the terms employed by the individual inspectors introducing great difficulty in translating them to a common basis, the full purpose of these inspections could be obtained by making a committee record of the findings, omitting any specific report at this time. Members filing data sheets for these inspections are as follows:

Pittsburgh.—Messrs. Buck, Cushman, Smith, Wheaton and Gibboney.

Annapolis.—Messrs. Buck, Cushman, Cooper, Smith, Wheaton and Gibboney.

The experience in these inspections indicated the necessity for the selection of standard terms for recording the various physical conditions presented by the rusted surfaces of the sheets, so that the various inspectors' data could be brought to a common basis for comparison. Standard terms for designating

Pl. S-1

AMERICAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON
CORROSION OF IRON AND STEEL
TEST OF UNCOATED SHEETS
Fort Sheridan, Ill.

EXPOSED APRIL 9, 1917

ROW No. 1 Date of Inspection ....

Designation		Condition of Rust										Remarks
		Texture					Color			Adherence		
Mark	Sheet No.	Very Smooth	Smooth	Medium	Coarse	Very Coarse	Light	Medium	Dark	Tight	Loose	
AA	11											
	12											
	13											
BB	4											
	5											
	6											
CC	2											
	9											
	10											
DD	18											
	19											
	20											
EE*	7											
	8											
	9											

*Open Annealed.

.... Inspector

Pl. S-2

ROW No. 1 Date of Inspection ....

Designation		Condition of Rust										Remarks
		Texture					Color			Adherence		
Mark	Sheet No.	Very Smooth	Smooth	Medium	Coarse	Very Coarse	Light	Medium	Dark	Tight	Loose	
HH	10											
	11											
	12											
II	10											
	11											
	12											
KK	4											
	5											
	18											
MM*	15											
	16											
	17											
SS	15											
	16											
	17											

*Open Annealed.

.... Inspector

Pl. S-3

ROW No. 1 Date of Inspection ....

Designation		Condition of Rust										Remarks
		Texture					Color			Adherence		
Mark	Sheet No.	Very Smooth	Smooth	Medium	Coarse	Very Coarse	Light	Medium	Dark	Tight	Loose	
TT	15											
	16											
	17											
UU	15											
	16											
	17											
VV	20											
	21											
	22											
XX	15											
	16											
	17											
OO	13											
	14											
	15											
CCC	13											
	14											
	15											

.... Inspector

FIG. 1.—Loose Leaf Inspection Form.

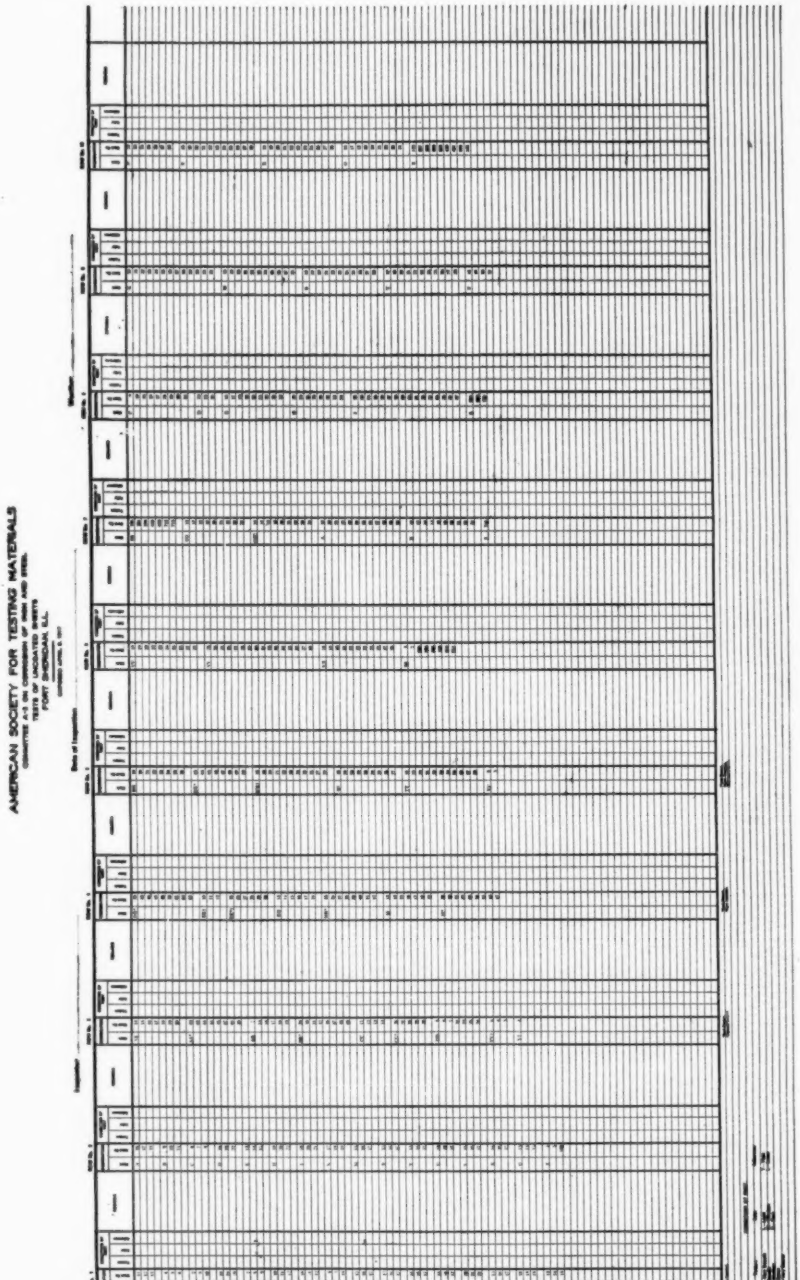


FIG. 2.—Inspector's Report Form.

Date of Inspection Oct. 8. 1917.

ROW No. 1

Designation		Condition of Rust: Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	11	VC	VC	VC	VC	C		C	C	C	L	L	L	L	M		L	L	L	L	L	L	•	L		L	L	L
	12	VC	VC	VC	VC	C		VC	C	VC	L	L	L	L	M		L	L	L	L	L	L		L		L	L	L
	13	VC	VC	VC	VC	M		C	M	C	L	L	L	L	M		L	L	M	L	L	L		L		L	L	L
BB	4	S	S	M	S	S		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	5	S	S	M	S	S		M	M	S	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	6	S	S	M	S	S		M	M	S	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
CC	8	M	M	C	M	M		C	M	M	L	M	M	M	L		M	M	M	T	T	T	•	T		L	T	L
	9	M	M	M	M	S		M	M	M	L	M	M	M	L		M	M	M	T	T	T		T		L	T	T
	10	M	M	M	M	S		M	M	M	L	M	M	M	L		M	M	M	T	T	T		T		L	T	T
DD	18	M	M	M	M	S		M	M	S	M	D	M	M	L		M	M	M	T	T	T	•	T		T	T	T
	19	M	M	M	M	S		M	M	S	M	D	M	M	L		M	M	M	T	T	T		T		T	T	T
	20	M	M	M	M	S		M	M	S	M	D	M	M	L		M	M	M	T	T	T		T		T	T	T
EE*	7	S	M	C	M	M		M	S	M	M	M	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	8	S	M	C	M	M		M	S	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	9	S	M	C	M	M		M	S	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
HH	10	S	S	M	S	S		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	L
	11	S	S	M	S	S		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	L
	12	S	S	M	S	S		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
II	10	S	VS	S	S	S		M	S	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	11	S	VS	S	S	S		M	S	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	12	S	VS	S	S	S		M	S	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
KK	4	M	S	M	C	C		M	C	C	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	5	S	VS	S	S	M		M	S	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	18	S	VS	S	S	M		M	S	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
MM*	15	M	M	M	M	C		M	M	M	M	M	D	M	M		D	M	L	T	T	T	•	T		T	T	T
	16	M	M	M	M	C		M	M	M	M	M	D	M	M		D	M	L	T	T	T		T		T	T	T
	17	M	M	M	M	C		M	M	M	M	M	D	M	M		D	M	L	T	T	T		T		T	T	T
SS	15	M	S	M	C	C		C	C	M	M	M	M	L	M		L	M	L	T	T	T	•	T		L	T	T
	16	M	S	M	C	C		C	C	M	M	M	M	L	M		L	M	L	T	T	T		T		L	T	T
	17	M	S	M	C	C		C	C	M	M	M	M	L	M		L	M	L	T	T	T		T		L	T	T
TT	15	M	S	M	C	M		C	M	M	M	D	D	M	L		D	M	M	T	T	T	•	T		T	T	T
	16	M	S	M	S	M		C	M	VS	M	D	D	M	L		D	M	M	T	T	T		T		T	T	T
	17	M	S	M	S	M		C	M	M	M	D	D	M	L		D	M	M	T	T	T		T		T	T	T
UU	15	S	VS	S	S	M		M	S	M	M	M	M	M	M		M	L	M	T	T	T	•	T		T	T	T
	16	S	VS	S	S	M		M	M	M	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
	17	S	VS	S	S	M		M	M	M	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
VV	20	S	S	M	S	M		M	S	C	M	M	M	M	M		M	L	M	T	T	T	•	T		T	T	T
	21	S	S	M	S	M		M	M	C	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
	22	S	S	M	S	M		M	M	M	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
XX	15	S	M	M	M	C		M	S	M	M	M	M	M	M		M	L	M	T	T	T	•	T		T	T	T
	16	S	M	M	M	C		M	S	M	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
	17	S	M	M	M	C		M	S	M	M	M	M	M	M		M	L	M	T	T	T		T		T	T	T
OO	13	M	M	C	C	C		C	M	C	M	D	M	M	D		D	M	D	T	L	T	•	L		T	T	T
	14	M	M	C	C	C		C	M	C	M	D	M	M	D		D	M	D	T	L	T		L		T	T	T
	15	M	M	C	C	C		C	M	C	M	D	M	M	D		D	M	D	T	L	T		L		T	T	T
CCC	13	M	M	M	M	C		C	M	VC	M	M	D	M	M		M	D	M	T	L	T	•	T		T	T	T
	14	M	M	M	M	C		C	M	VC	M	M	D	M	M		M	D	M	T	L	T		T		T	T	T
	15	M	M	M	M	C		C	M	VC	M	M	D	M	M		M	D	M	T	L	T		T		T	T	T

* [illegible]

ROW No. 2

Designation		Condition of Rust: Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
A	16	VC	VC	VC	VC	VC		C	M	C	L	L	L	L	L		L	L	L	L	L	L	•	L		L	L	L
	17	VC	VC	VC	VC	VC		C	C	C	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
	18	VC	VC	VC	VC	VC		C	C	C	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
B	9	S	S	M	S	S		M	S	M	M	M	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	10	S	S	M	S	S		M	S	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
	11	S	S	M	S	S		M	S	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
C	6	S	S	M	S	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T	•	T		T	T	T
	7	S	S	M	S	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	8	S	S	M	S	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
D	16	S	M	M	S	M		M	M	M	M	L	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	19	S	M	M	S	M		M	M	M	M	L	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	S	M	M	M	M		M	M	C	M	L	M	M	M		L	M	M	T	T	T		T		T	T	T
E	13	S	M	M	C	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	14	S	M	M	C	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	15	S	M	M	C	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
H	19	M	S	S	M	M		M	M	M	M	D	D	M	M		D	M	M	T	T	T	•	T		T	T	T
	20	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	22	M	VS	S	S	S		M	M	M	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
I	19	M	VS	VS	S	S		M	M	DS	M	D	M	M	M		D	M	M	T	T	T	•	T		T	T	T
	20	M	VS	VS	S	S		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	S	S	M	S		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
K	17	M	VS	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	18	M	VS	M	S	M		M	M	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	19	M	VS	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
M	15	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	16	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
S	15	M	M	C	C	M		C	C	M	M	M	M	M	M		L	L	L	T	T	T	•	T		T	T	T
	16	M	M	C	C	M		C	C	M	M	M	M	M	M		L	L	L	T	T	T		T		T	T	T
	17	M	M	C	C	M		C	C	M	M	M	M	M	M		L	L	L	T	T	T		T		T	T	T
T	15	S	VS	M	M	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	16	S	VS	M	M	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	VS	M	M	M		M	M	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
U	15	S	S	M	M	M		M	C	C	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	16	S	S	M	M	M		M	C	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	S	M	M	M		M	C	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
V	15	S	VS	M	M	S		M	M	S	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	16	S	VS	M	M	S		M	M	S	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	VS	M	M	S		M	M	S	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
X	15	C	M	C	C	C		C	VC	C	M	M	M	M	M		L	M	M	T	T	T	•	L		T	T	T
	16	C	M	C	M	C		C	VC	C	M	M	M	M	M		L	M	M	T	T	T		L		T	T	T
	17	C	M	C	M	C		C	VC	C	M	M	M	M	M		L	M	M	T	T	T		L		T	T	T
O	13	C	C	VC	VC	M		C	VC	C	L	M	M	M	M		M	M	M	L	L	L	•	L		L	L	L
	14	C	C	VC	VC	M		C	VC	C	L	M	M	M	M		M	M	M	L	L	L	•	L		L	L	L
	15	C	C	VC	VC	M		C	VC	C	L	M	M	M	M		M	M	M	L	L	L	•	L		L	L	L
Z	4	C	VC	VC	C	C		C	VC	C	L	L	M	L	M		M	L	M	L	L	L	•	L		L	L	T
	5	C	VC	VC	VC	C		C	VC	C	L	L	M	L	M		M	L	M	L	L	L		L		L	L	T
	100	S	VS	VS	VS	S		M	VC	VS	D	D	D	D	D		D	M	D	T	T	T		T		T	T	T

ROW No. 3

Designation		Condition of Rust: Texture									Color									Adherence		
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper
AA	14	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	15	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	16	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	17	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	18	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	19	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
	20	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L
AA*	42	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	43	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	44	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	45	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	46	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	47	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	48	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
	49	C	C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL
BB	7	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	15	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	16	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	17	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	18	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	19	S	S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T
BB*	29	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	30	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	31	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	32	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	36	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	37	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	38	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
	39	VS	VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T
CC	11	M	M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL
	12	M	M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL
	13	M	M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL
	14	M	M	C	C	C		C	VC	C	M	M	M	M	M		L	M	L	T	T	L
CC*	26	S	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T
	27	S	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T
	28	S	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T
	29	S	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T
	30	S	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T
DD	5	M	S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	6	M	S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	7	M	S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T
	21	M	M	C	VC	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T
	22	M	M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T
	23	M	M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T
	24	M	M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T
YY†	6	M	M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L
	4	M	M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L
	5	M	M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L
Y†	4	M	VS	M	S	S		M	C	M	M	L	L	M	L		L	L	L	T	T	T

* Sand Blasted.
† Exposed 6-13-17.

-AUPPERLE-
Notes: None.

CONDITION OF RUST.

Texture: VS—Very Smooth; S—Smooth; M—Medium; C—Coarse; VC—Very Coarse.
Color: L—Light; M—Medium; D—Dark.
Adherence: T—Tight; L—Loose.

— INSPECTION COMMITTEE —

J. H. Gibboney, Chairman – Norfolk & Western Ry. Co.
J. A. Aupperle, – American Rolling Mill Co.
D. M. Buck, – American Sheet & Tin Plate Co.
W. A. Cooper, – Alan Wood Iron & Steel Co.
W. R. Fleming, – The Andrews Steel Co.
D. J. McAdam, Jr. – U.S. Navy, Bureau Steam Engineering.
M. E. McDonnell, – Pennsylvania Railroad Co.
H. E. Smith, – New York Central Railroad Co.
F. B. Wheaton, – U.S. Army, Quartermaster's Corps.

TABLE I.—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT F

AMERICAN SOCIETY FOR TESTING MATE

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

FORT SHERIDAN, ILL.

EXPOSED APRIL 9, 1917

…ct. 8, 1917

Color 5 Gibboney	Color 6 McAdam	Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
L		L	L	L	L	L	L	•	L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
L		L	L	L	L	L	L		L		L	L	L
M		M	M	M	L	L	TL	•	L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	L	L	TL		L		L	L	T
M		M	M	M	T	T	T	•	T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T	•	T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		L	M	L	T	T	TL	•	L		T	T	T
M		L	M	L	T	T	TL		L		T	T	T
M		L	M	L	T	T	TL		L		T	T	T
M		L	M	L	T	T	L		L		T	T	T
M		M	M	M	T	T	T	•	T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T		T		T	T	T
M		M	M	M	T	T	T	•	L		T	T	T
M		M	M	M	T	T	T		L		T	T	T
M		M	M	M	T	T	T		L		T	T	T
M		M	M	M	T	T	T		L		T	•	T
M		M	M	M	T	T	T		L		T		T
M		M	M	M	T	T	T		L		T		T
M		M	M	M	T	T	T		L		T		T
L		L	L	L	T	T	L	•	L		T	T	T
L		L	L	L	T	T	L		L		T	T	T
L		L	L	L	T	T	L		L		T	T	T
L		L	L	L	T	T	T	•	L		T	T	T

ROW No. 4

Designation: Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
DD*	39	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T	•	T		T	T	T
	40	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	44	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	45	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	46	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	50	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	51	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	52	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	53	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
EE*	10	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	11	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
	12	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
EE*†	25	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	26	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	27	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	28	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	29	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	30	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
HH	13	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	14	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	15	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	16	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	18	S	S	C	M	M		M	C	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
HH*	35	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T	•	T		T	T	T
	36	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	37	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	38	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	39	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	40	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	41	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	42	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
II	13	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	14	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	15	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	16	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	18	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	19	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
JJ*	39	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T	•	T		T	T	T
	40	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	41	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	42	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	43	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	44	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	45	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	46	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	47	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T

ROW No. 5

Designation: Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
KK	19	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	20	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	21	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	23	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	24	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	25	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	26	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
KK*	43	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T	•	T		T	T	T
	44	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	45	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	46	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	47	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	48	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	49	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	50	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
MM*	18	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL	•	T		T	•	T
	19	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	20	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	21	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	22	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	23	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	24	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	25	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	26	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	27	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	28	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
SS	18	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	19	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	20	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	23	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	24	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	25	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	26	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	27	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
TT	18	M	VS	M	M	M		M	C	M	M	D	D	M	D		D	•	M	T	T	T	•	T		T	•	T
	19	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	20	M	VS	M	M	M		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	21	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	22	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	23	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	24	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	25	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	26	M	VS	M	M	M		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	27	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	28	M	VS	M	M	M		M	C	C	M	D	D	M	D		D		M	T	T	T		T		T		T
Y*†	6	C	M	VC	C	C		C	VC	VC	L	L	L	L	L		L	L	L	L	T	L	•	L		L	T	L
	5	M	VS	M	S	M		S	M	M	M	M	L	M	L		L	L	L	T	T	T		T		T	T	T

ROW No. 6

Designation: Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck
UU	18	M	VS	M	S	M		M	M	M	M	M
	19	M	VS	M	S	M		M	M	M	M	M
	20	M	VS	M	S	M		C	M	M	M	M
	22	M	VS	M	M	M		C	M	M	M	M
	23	M	VS	M	S	M		M	M	M	M	M
	24	M	VS	M	M	M		M	M	M	M	M
	25	M	VS	M	M	M		M	M	M	M	M
	26	M	VS	M	S	M		C	M	M	M	M
	27	M	VS	M	S	M		C	M	M	M	M
	28	M	VS	M	M	M		C	M	M	M	M
VV	23	M	VS	M	S	M		M	M	M	M	D
	24	M	VS	M	S	M		M	M	M	M	D
	25	M	VS	M	S	M		M	M	M	M	D
	26	M	VS	C	S	M		M	M	C	M	D
	27	M	VS	C	C	C		C	C	C	M	D
	28	M	VS	C	M	C		C	C	C	M	D
	29	M	VS	M	M	M		M	M	M	M	D
	30	M	VS	M	S	M		M	M	M	M	D
	31	M	VS	M	S	M		M	M	M	M	D
	32	M	VS	M	S	M		M	M	C	M	D
	33	M	VS	M	S	M		M	M	M	M	D
	34	M	VS	M	S	M		M	M	M	M	D
	35	M	VS	M	S	M		M	M	M	M	D
	36	M	VS	C	S	M		M	C	C	M	D
	37	M	VS	M	M	M		M	M	C	M	D
	38	M	VS	M	M	M		M	M	M	M	D
XX	18	M	M	M	C	M		C	C	M	M	M
	19	M	M	M	C	M		C	C	M	M	M
	20	M	M	M	C	M		C	C	M	M	M
	21	M	M	M	C	M		C	C	M	M	M
	22	M	M	M	C	M		C	C	M	M	M
	23	M	M	M	C	M		C	C	M	M	M
	24	M	M	M	C	M		C	C	M	M	M
	25	M	M	M	C	M		M	C	M	M	M
	26	M	M	M	C	M		M	C	M	M	M
	27	M	M	M	C	M		C	C	M	M	M
	28	M	M	M	C	M		C	C	M	M	M
ZZ	5	C	C	C	C	M		M	C	C	M	D
	7	C	VC	C	C	M		C	C	C	M	D
	308	C	VS	M	S	M		M	M	M	M	D
	309	C	VS	M	S	M		M	M	M	M	D
	505	C	VS	M	S	M		C	M	M	M	D
	506	C	VS	M	S	M		M	M	C	M	D
	610	C	VS	S	S	M		M	M	M	M	D
	611	C	VS	S	S	M		M	M	M	M	D

* Sand Blasted.
† Open Annealed.

—BUCK—

General Condition very Similar to Annapolis Test at Time of first Inspection. Mill Scale nearly all off except on some Open Annealed Sheets.

Bullet Hole in K 21, 7th Corrugation 5/6 way up.
" " " U 25, 7th " 1/2 " "
" " " U 26, 1st " 3/4 " "
" " " U 26, 3rd " 5/6 " "

—COOPER—

"TL" indicates Medium Adherence. It was noticeable that the Sand Blasted Sheets were Finer in Texture and Darker in Color.

CC 9 Break in Corrugation Lower Edge
EE* 7-8-9, MM* 15-16-17, TT 15-16-17, UU 15-16-17, VV 20-21-22: Some Mill Scale Spots
XX 15 Mill Scale C 6 Little Mill Scale
M 16-17, S 15-16, BB 18: Some Mill Scale
BB 19 Scat Lower Right Hand Corner.
CC 11-12 Break in Corrugation Lower Edge.
CC* 26 Break in Corrugation Lower Edge.
YY*†6-4-5, EE* 10-11-12: Some Mill Scale.
EE*†25 Break Top Corrugation 4th from Left Side.
KK 21 Some Mill Scale.
MM* 18 to 28 inc. Some Mill Scale.
TT 18 - 28 " Little Mill Scale Spots.
Y†6 Some Mill Scale.
OO 21 Break in Corrugation Lower Left Hand Corner.
K 21 Rifle Hole Top Right Hand Corner.
U 25 Hole in Middle.
U 26 3-Holes Left Hand Upper Corner.

—FLEMING—

EE*†25 Crack in 4th Co
VV 38 Deep Pit in Middl
from Right.
K 21 Rifle Hole.
M 19 & 21 Pitted.
U 25 Large Rifle Hole.
U 26 – 3 Rifle Holes.
• Designations not Show

TABLE I.—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT FORT SHERIDAN, ILL., OCTOBER

AMERICAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

FORT SHERIDAN, ILL.

EXPOSED APRIL 9, 1917

Date of Inspection *Oct. 8, 1917*

Condition of Rust (cut-off row at left edge of sheet)

Texture 2 Buck	Texture 3 Cooper	Texture 4 Fleming	Texture 5 Gibboney	Texture 6 McAdam	Texture 7 McDonnell	Texture 8 Smith	Texture 9 Wheaton	Color 1 Aupperle	Color 2 Buck	Color 3 Cooper	Color 4 Fleming	Color 5 Gibboney	Color 6 McAdam	Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	Adherence 2 Buck	Adherence 3 Cooper	Adherence 4 Fleming	Adherence 5 Gibboney	Adherence 6 McAdam	Adherence 7 McDonnell	Adherence 8 Smith	Adherence 9 Wheaton
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L	•	L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL	•	L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
C	C	VC	C		M	C	C	M	M	M	M	M		M	M	M	L	L	TL		L		L	L	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	M		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
VS	S	S	S		M	S	S	D	D	D	M	M		M	M	M	T	T	T		T		T	T	T
M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL	•	L		T	T	T
M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL		L		T	T	T
M	C	C	C		C	C	M	M	M	M	M	M		L	M	L	T	T	TL		L		T	T	T
M	C	C	C		C	VC	C	M	M	M	M	M		L	M	L	T	T	L		L		T	T	T
S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T	•	L		T	T	T
S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T		L		T	T	T
S	C	M	C		M	M	M	M	D	D	M	M		M	M	M	T	T	T		L		T	T	T
M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T		L		T	•	T
M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T		L		T		T
M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T		L		T		T
M	C	M	C		M	C	M	M	D	D	M	M		M	M	M	T	T	T		L		T		T
M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L	•	L		T	T	T
M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L		L		T	T	T
M	C	M	M		M	VC	C	M	L	L	M	L		L	L	L	T	T	L		L		T	T	T
VS	M	S	S		M	C	M	M	L	L	M	L		L	L	L	T	T	T	•	L		T	T	T

ROW No. 4

Mark	Sheet No.	Texture 1 Aupperle	Texture 2 Buck	Texture 3 Cooper	Texture 4 Fleming	Texture 5 Gibboney	Texture 6 McAdam	Texture 7 McDonnell	Texture 8 Smith	Texture 9 Wheaton	Color 1 Aupperle	Color 2 Buck	Color 3 Cooper	Color 4 Fleming	Color 5 Gibboney	Color 6 McAdam	Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	Adherence 2 Buck	Adherence 3 Cooper	Adherence 4 Fleming	Adherence 5 Gibboney	Adherence 6 McAdam	Adherence 7 McDonnell	Adherence 8 Smith	Adherence 9 Wheaton
DD*	39	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T	•	T		T	T	T
	40	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	44	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	45	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	46	S	VS	S	S	S		M	M	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	50	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	51	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	52	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
	53	S	VS	S	S	S		M	S	S	M	D	M	M	M		M	M	L	T	T	T		T		T	T	T
FF†	10	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	11	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
	12	M	M	C	C	M		M	C	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T
EE*	25	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	26	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	27	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	28	M	S	M	S	S		M	M	S	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	29	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	30	M	S	M	S	S		M	M	M	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
HH	13	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T	•	T		T	T	T
	14	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	15	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	16	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	S	C	M	M		M	M	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
	18	S	S	C	M	M		M	C	C	M	D	D	M	M		M	M	M	T	T	T		T		T	T	T
HH*	35	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T	•	T		T	T	T
	36	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	37	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	38	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	39	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	40	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	41	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
	42	S	VS	S	S	S		M	M	S	M	D	D	L	M		D	M	M	T	T	T		T		T	T	T
II	13	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	14	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	15	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	16	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	18	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	19	M	S	M	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
JJ*	39	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T	•	T		T	T	T
	40	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	41	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	42	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	43	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	44	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	45	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	46	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	47	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T

ROW No. 5

Mark	Sheet No.	Texture 1 Aupperle	Texture 2 Buck	Texture 3 Cooper	Texture 4 Fleming	Texture 5 Gibboney	Texture 6 McAdam	Texture 7 McDonnell	Texture 8 Smith	Texture 9 Wheaton	Color 1 Aupperle	Color 2 Buck	Color 3 Cooper	Color 4 Fleming	Color 5 Gibboney	Color 6 McAdam	Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	Adherence 2 Buck	Adherence 3 Cooper	Adherence 4 Fleming	Adherence 5 Gibboney	Adherence 6 McAdam	Adherence 7 McDonnell	Adherence 8 Smith	Adherence 9 Wheaton
KK	19	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	20	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	21	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	23	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	24	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	25	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	26	M	S	M	S	C		M	M	S	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
KK*	43	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T	•	T		T	T	T
	44	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	45	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	46	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	47	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	48	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	49	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	50	S	VS	S	VS	S		S	S	VS	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
MM‡	18	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL	•	T		T	•	T
	19	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	20	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	21	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	22	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	23	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	24	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	25	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	26	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	27	C	M	C	C	C		M	VC	M	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
	28	C	M	C	C	C		M	VC	C	M	D	M	M	M		M	M	M	T	T	TL		T		T		T
SS	18	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T	•	T		T	T	T
	19	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	20	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	23	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	24	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	25	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	26	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	27	M	S	C	C	M		C	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
TT	18	M	VS	M	M	M		M	C	M	M	D	D	M	D		D	•	M	T	T	T	•	T		T	•	T
	19	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	20	M	VS	M	M	M		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	21	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	22	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	23	M	VS	M	M	M		M	C	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	24	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	25	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	26	M	VS	M	M	M		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	27	M	VS	M	M	S		M	M	M	M	D	D	M	D		D		M	T	T	T		T		T		T
	28	M	VS	M	M	M		M	C	C	M	D	D	M	D		D		M	T	T	T		T		T		T
YY‡	6	C	M	VC	C	C		C	VC	VC	L	L	L	L	L		L	L	L	L	T	L	•	L		L	T	L
	5	M	VS	M	S	M		S	M	M	M	M	L	M	L		L	L	L	T	T	T		T		T	T	T

ROW No. 6

Mark	Sheet No.	Texture 1 Aupperle	Texture 2 Buck	Texture 3 Cooper	Texture 4 Fleming	Texture 5 Gibboney	Texture 6 McAdam	Texture 7 McDonnell	Texture 8 Smith	Texture 9 Wheaton	Color 1 Aupperle	Color 2 Buck	Color 3 Cooper	Color 4 Fleming	Color 5 Gibboney	Color 6 McAdam	Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	Adherence 2 Buck	Adherence 3 Cooper	Adherence 4 Fleming	Adherence 5 Gibboney	Adherence 6 McAdam	Adherence 7 McDonnell	Adherence 8 Smith	Adherence 9 Wheaton
UU	18	M	VS	M	S	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T	•	T		L	T	T
	19	M	VS	M	S	M		M	M	M	M	M	M	M	D		L	M	M	T	T	T		T		L	T	T
	20	M	VS	M	S	M		C	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	22	M	VS	M	M	M		C	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	23	M	VS	M	S	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	24	M	VS	M	M	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	25	M	VS	M	M	M		M	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	26	M	VS	M	S	M		C	M	M	M	M	M	M	D		L	M	M	T	T	T		T		L	T	T
	27	M	VS	M	S	M		C	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
	28	M	VS	M	M	M		C	M	M	M	M	M	M	M		L	M	M	T	T	T		T		L	T	T
VV	23	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T	•	T		T	T	T
	24	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	25	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	26	M	VS	C	S	M		M	M	C	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	27	M	VS	C	C	C		C	C	C	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	28	M	VS	C	M	C		C	C	C	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	29	M	VS	M	M	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	30	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	31	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	32	M	VS	M	S	M		M	M	C	M	D	M	M	D		L	M	M	T	T	T		T		T	T	T
	33	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	34	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	35	M	VS	M	S	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	36	M	VS	C	S	M		M	C	C	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	37	M	VS	M	M	M		M	M	C	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
	38	M	VS	M	M	M		M	M	M	M	D	M	M	M		L	M	M	T	T	T		T		T	T	T
XX	18	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T	•	T		T	T	T
	19	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	20	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	21	M	M	M	C	M		C	C	M	M	M	M	M	D		M	M	M	T	T	T		T		T	T	T
	22	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	23	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	24	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	25	M	M	M	C	M		M	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	26	M	M	M	C	M		M	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	27	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
	28	M	M	M	C	M		C	C	M	M	M	M	M	M		L	M	M	T	T	T		T		T	T	T
ZZ	6	C	C	C	C	M		M	C	C	M	D	D		M		L	M	M	T	L	T	•	T		T	T	T
	7	C	VS	C	C	M		C	C	C	M	D	D		M		L	M	M	T	L	T		T		T	T	T
	308	C	VS	M	S	M		M	M	M	M	D	D		M		M	M	M	T	T	T		T		T	T	T
	309	C	VS	M	S	M		M	M	M	M	D	D		M		M	M	M	T	T	T		T		T	T	T
	505	C	VS	M	S	M		C	M	M	M	D	D		M		M	M	M	T	T	T		T		T	T	L
	506	C	VS	M	S	M		M	M	C	M	D	D		M		M	M	M	T	T	T		T		T	T	L
	610	C	VS	S	S	M		M	M	M	M	D	D		M		D	M	D	T	T	T		T		T	T	T
	611	C	VS	S	S	M		M	M	M	M	D	D		M		M	M	M	T	T	T		T		T	T	T

ROW No. (7; Texture only visible)

Mark	Sheet No.	Texture 1 Aupperle	Texture 2 Buck	Texture 3 Cooper	Texture 4 Fleming	Texture 5 Gibboney	Texture 6 McAdam	Texture 7 McDonnell	Texture 8 Smith	Texture 9 Wheaton
ZZ	106	S	S	S	S	M		M	M	M
	205	S	S	S	S	M		M	M	M
	206	S	S	S	S	M		M	M	M
	420	C	C	M	C	M		C	M	C
	422	C	C	M	C	M		C	M	C
	712	S	S	M	S	M		M	M	M
	713	S	S	M	S	M		M	M	M
OO	16	M	M	M	M	C		M	C	C
	17	M	M	M	M	C		M	C	C
	18	M	M	M	M	C		M	C	C
	19	M	M	M	M	C		M	C	C
	20	M	M	C	M	C		M	C	C
	21	M	M	C	M	C		M	C	C
	22	M	M	C	M	C		M	C	C
	23	M	M	C	M	C		M	C	C
	24	M	M	C	M	C		M	C	C
CCC	16	M	M	C	C	C		C	C	M
	17	M	M	C	C	C		M	C	C
	18	M	M	C	M	C		M	C	M
	19	M	M	C	M	C		M	C	M
	20	M	M	C	M	C		M	C	M
	21	M	M	C	M	C		C	C	C
	22	M	M	C	M	C		M	C	M
	23	M	M	C	M	C		M	C	M
	24	M	M	C	C	C		C	C	C
A	19	C	VC	VC	C	VC		C	C	C
	20	C	VC	VC	C	VC		C	C	C
	21	C	VC	VC	C	VC		C	C	C
	22	C	VC	VC	C	VC		C	C	C
	23	C	VC	VC	C	VC		C	C	C
	24	C	VC	VC	C	VC		VC	C	C
	25	C	VC	VC	C	VC		C	C	C
	26	C	VC	VC	C	VC		C	C	C
	27	C	VC	VC	C	VC		C	C	C
	28	C	VC	VC	C	C		C	C	C
	29	C	VC	VC	C	VC		C	C	C
	30	C	VC	VC	C	VC		C	C	C
B	12	S	S	M	S	M		M	M	S
	13	S	S	M	S	M		M	M	S
	14	S	S	M	S	M		M	M	S
	15	S	S	M	S	M		M	M	S
	16	S	S	M	S	M		M	M	S
	29	S	S	M	S	M		M	M	S
	30	S	S	M	S	M		M	M	S
	31	S	S	M	S	M		M	M	S
	32	S	S	M	S	M		M	M	S
	33	S	S	M	S	M		M	M	S
Z	710	S	VS	S	VS	M		M	M	S

*Sand Blasted. †Open Annealed. ‡Lead Blasted; Open Annealed; Exposed 4-12-17.

—BUCK—

General Condition very Similar to Annapolis Test at Time of First Inspection. Mill Scale nearly all off except on some Open Annealed Sheets.

Bullet Hole in K 21, 7th Corrugation 3/4 way up.
" " " U 26, 7th " 1/4 " "
" " " U 26, 1st " 3/4 " "
" " " U 26, 3rd " 5/8 " "

—COOPER—

"TL" indicates Medium Adherence. It was noticeable that the Sand Blasted Sheets were Finer in Texture and Darker in Color.

CC 9 Break in Corrugation Lower Edge

EE* 7-8-9 } Some Mill Scale Spots
MM* 15-16-17 " " " "
TT 15-16-17 " " " "
UU 15-16-17 " " " "
VV 20-21-22 " " " "

XX 15 Mill Scale C 6 Little Mill Scale

M 16-17 } Some Mill Scale
S 15-16 " " "
BB 18 " " "

BB 19 Scat Lower Right Hand Corner.

CC 11-12 Break in Corrugation Lower Edge.

CC* 26 Break in Corrugation Lower Edge.

YY*†6-4-5 } Some Mill Scale.
EE* 10-11-12 " " "

EE*† 25 Break Top Corrugation 4th from Left Side.

KK 21 Some Mill Scale.

MM* 18 to 28 inc. Some Mill Scale.

TT 18 – 28 " Little Mill Scale Spots.

Y† 6 Some Mill Scale.

OO 21 Break in Corrugation Lower Left Hand Corner.

K 21 Rifle Hole Top Right Hand Corner.

U 25 Hole in Middle.

U 26 3-Holes Left Hand Upper Corner.

—FLEMING—

EE*† 25 Crack in 4th Corrugation above Bottom Nail.

VV 38 Deep Pit in Middle of Sheet 2nd Corrugation from Right.

K 21 Rifle Hole.

M 19 & 21 Pitted.

U 25 Large Rifle Hole.

U 26 – 3 Rifle Holes.

* Designations not Shown.

—GIBBONEY—

BB 19 Scat.

CC 11 to 14 inc. } Split in Corr[...]
CC* 26 to 30 " " "

EE*† 25 Break.

MM* 18 to 28 inc. Color Medi[...] Probably Due to [...]

OO 21 Break.

K 21 One Bullet Hole.

U 25 " " "

U 26 Two " Holes.

OCTOBER 8, 1917.

PLATE I.
PROC. AM. SOC. TEST. MATS.
VOL. XVIII, PART I.
REPORT OF COMMITTEE A-5:
CORROSION TESTS.

Weather *Cold and Clear*

ROW No. 6

Designation		Condition of Rust: Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
C	9	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T	*	T		T	T	T
	10	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	18	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	19	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	27	M	S	M	S	M		C	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	28	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	29	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	30	M	S	M	S	M		M	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
	31	M	S	M	S	M		C	M	M	M	M	M	M	M		M	M	L	T	T	T		T		T	T	T
D	24	M	S	M	M	M		M	M	M	M	M	M	M	M		M	M	M	T	T	T	*	L		T	T	T
	25	M	S	M	M	M		M	M	M	M	M	M	M	M		M	M	M	T	T	T		L		T	T	T
	28	M	S	M	M	M		M	M	M	M	M	M	M	M		M	M	M	T	T	T		L		T	T	T
E	16	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T	*	T		T	T	T
	17	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	18	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	19	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	22	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	23	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	M	S	M	M	M		M	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
H	23	S	S	M	S	M		S	M	S	M	D	MD	M	M		D	M	M	T	T	T	*	T		T	T	T
	24	S	S	M	S	M		S	M	S	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	S	M		S	M	S	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	26	C	S	M	S	M		S	M	M	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	29	S	S	M	S	S		S	M	S	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	33	S	S	M	S	M		S	M	S	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	35	S	S	M	S	M		S	M	M	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	36	S	S	M	S	M		M	C	M	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T
	22	C	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T	*	T		T	T	T
	23	M	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	M	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	M	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	M	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	M	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	C	VS	M	C	M		M	M	C	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	29	S	VS	S	S	M		S	S	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	30	S	VS	S	S	M		S	S	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	31	S	VS	M	S	M		S	S	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	32	S	VS	S	S	M		S	S	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	33	S	VS	M	M	M		M	M	C	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	34	S	VS	S	S	M		S	S	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	35	S	VS	M	M	M		M	M	[illegible]	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	36	S	VS	M	M	M		S	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	37	S	VS	M	S	M		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
Z	805	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T	*	T		T	T	T
	806	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	M	T	T	T		T		T	T	T
	709	S	VS	S	S	S		S	S	S	M	D	MD	M	M		D	M	M	T	T	T		T		T	T	T

ROW No. 8

Designation		Condition of Rust: Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
K	20	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T	*	T		T	T	T
	21	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	23	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	24	M	VS	S	S	M		M	S	C	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	25	M	VS	S	S	M		M	M	M	M	D	M	M	M		M	M	M	T	T	T		T		T	L	T
	26	M	VS	S	S	M		M	S	VC	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	27	M	VS	M	M	M		C	C	C	M	D	M	M	M		M	M	M	T	T	T		T		T	L	T
	28	M	VS	M	M	M		M	M	C	M	D	M	M	M		M	M	M	T	T	T		T		T	L	T
	29	M	VS	M	M	M		M	M	VC	M	D	M	M	M		M	M	M	T	T	T		T		T	L	T
	30	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	31	M	VS	S	S	M		M	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	32	M	VS	S	S	M		M	S	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
M	18	M	VS	M	S	M		M	M	S	M	D	M	M	M		M	M	M	T	T	T	*	T		T	T	T
	19	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	M	VS	M	M	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	VS	M	M	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	22	M	VS	M	M	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	23	M	VS	M	M	M		M	M	C	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	M	VS	M	M	M		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	M	VS	M	M	M		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	M	VS	M	M	M		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	M	VS	M	M	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	M	VS	M	M	M		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
S	18	M	M	M	M	M		C	M	C	M	M	L	M	M		M	M	M	T	T	T	*	T		T	L	T
	19	M	M	M	M	M		C	M	C	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	20	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	21	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	22	M	M	M	M	M		C	M	C	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	23	M	M	M	M	M		C	M	C	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	24	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	25	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	26	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	27	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
	28	M	M	M	M	M		C	M	M	M	M	L	M	M		M	M	M	T	T	T		T		T	L	T
T	18	M	VS	M	S	M		M	C	M	M	D	M	M	M		M	M	M	T	T	T	*	T		T	T	T
	19	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	VS	M	S	M		M	M	S	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	22	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	23	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	M	VS	M	S	M		M	M	S	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
U	18	M	VS	M	M	M		M	C	M	M	D	M	M	M		D	M	M	T	T	T	*	T		T	T	T
	19	M	VS	M	M	M		M	C	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	M	VS	M	M	S		M	C	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	VS	M	M	M		M	C	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T

ROW No. 10

Designation		Condition of Rust: Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
C	22	M	S	C	C	M		M	M	C	M	M	L	*	M		L	M	L	T	T	T	L	T		T	L	T
	23	M	S	C	C	M		C	M	C	M	M	L		M		L	M	L	T	T	T	L	T		T	L	T
	24	M	S	C	C	M		M	M	C	M	M	L		M		M	M	L	T	T	T	L	T		T	L	T
	25	M	S	C	C	M		C	M	C	M	M	L		M		M	M	L	T	T	T	L	T		T	L	T
	26	M	S	C	C	M		C	M	C	M	M	L		M		L	M	L	T	T	T	L	T		T	L	T
	27	M	S	C	C	M		C	M	C	M	M	L		M		L	M	L	T	T	T	L	T		T	L	T
	28	M	S	C	C	M		C	M	C	M	M	L		M		M	M	L	T	T	T	L	T		T	L	T
V	18	S	VS	M	M	M		C	M	M	M	M	M	*	M		M	M	L	T	T	T	M	T		T	T	T
	19	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	20	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	21	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	22	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	23	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	24	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	25	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	26	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	27	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
	28	S	VS	M	M	M		C	M	M	M	M	M		M		M	M	L	T	T	T	M	T		T	T	T
X	18	M	M	M	M	C		C	M	C	M	M	M	*	M		L	M	L	T	T	T	M	T		T	T	T
	19	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	20	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	21	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	22	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	23	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	24	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	25	M	M	M	M	C		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	26	M	M	M	M	M		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	27	M	M	M	M	M		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
	28	M	M	M	M	M		C	M	C	M	M	M		M		L	M	L	T	T	T	M	T		T	T	T
O	16	C	VC	VC	C	VC		VC	VC	VC	L	M	M	*	M		M	L	L	L	L	TL	M	L		L	L	L
	17	C	C	C	C	C		C	C	M	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	18	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	19	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	20	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	21	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	22	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	23	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
	24	C	C	C	C	C		C	C	C	L	M	M		M		M	M	M	L	L	TL	M	L		L	L	L
E	110	S	VS	S	S	S		S	S	S	M	D	D	*	M		D	M	M	T	T	T	M	T		T	T	T
	207	S	VS	S	S	S		M	S	S	M	D	D		M		D	M	M	T	T	T	M	T		T	T	T
	208	S	VS	S	S	S		M	S	S	M	D	D		M		D	M	M	T	T	T	M	T		T	T	T
	300	S	VS	S	S	S		M	M	S	M	D	D		M		D	M	M	T	T	T	M	T		T	T	T
	306	S	VS	S	S	S		M	M	S	M	D	D		M		D	M	M	T	T	T	M	T		T	T	T
	420	S	M	M	M	M		C	C	M	M	M	M		M		D	L	M	T	L	T	M	T		L	L	T
	421	S	M	M	M	M		C	C	M	M	M	M		M		D	L	M	T	L	T	M	T		L	L	T
	306	S	VS	S	S	S		M	S	S	M	D	M		M		D	M	M	T	T	T	M	T		T	T	T
	308	S	VS	S	S	S		M	S	S	M	D	M		M		D	M	M	T	T	T	M	T		T	T	T

—...EY—
...t.
...} Split in Corrugation at End.
...} " " " " "
...eak.
...8 inc. Color Medium to Dark
...robably Due to Mill Scale.
...
...ullet Hole.
... " "
... " Holes.

— Mc ADAM —
Did not make this Inspection.

— Mc DONNELL —
U 18 to 28 inc. Rust, somewhat Loose.
U 28 – 38 " Color might be Rated Medium. Rust not very tight.
S-18 to 28 " Scale only Moderately tight.
XX 18-19-20 & 22 to 28 inc. Rust not very tight.
U 22 to 28 inc. Rust only Moderately tight.
X 18 " 28 " " " " "

— SMITH —
K 24 Small Hole in Right Upper Corner. Probably Bullet Hole.
V 25 Punched or Shot Hole near Center.
V 26 Two " " " Holes " Upper Left Corner.
* Designations not Shown.

— WHEATON —
EE* 7 to 9 inc. Traces of Scale.
KK 4 & 5 " " "
MM* 15 to 17 inc. " " "
VV 20 " 22 " " " "
E 13 " 15 " " " "
A 16 " 18 " " " "
M 15 " 17 " " " "
BB 17 Coarse Patches.
EE† 10 Scale in Strips.
EE*† 27 Coarse Patches.
II 14, 15 & 18 " "
MM† 18 to 28 inc. Scale in Strips.
Y† 5 Streaky.
H 28 Traces of Scale.
M 23 Pitted.
T 21 Traces of Scale.
X 23 " " "

Jas. H. Gibboney
Chairman Inspection Committee

Date of Inspection Oct. 9, 1917.

ROW No. 1

CONDITION OF RUST. Inspectors: 1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 Mc Adam, 7 Mc Donnell, 8 Smith, 9 Wheaton (each group lists inspectors 1–9; – = blank)

Mark	Sheet No.	Texture 1 2 3 4 5 6 7 8 9	Color 1 2 3 4 5 6 7 8 9	Adherence 1 2 3 4 5 6 7 8 9
AA	21	VC VC VC VC VC – VC VC C	L L L L L – L L L	L L L L L – L L L
	22	VC VC VC VC VC – VC VC C	L L L L L – L L L	L L L L L – L L L
	23	VC VC VC VC VC – VC VC C	L L L L L – L L L	L L L L L – L L L
	24	VC VC VC VC VC – VC VC C	L L L L L – L L L	L L L L L – L L L
BB	8	M S M M M – M M M	M D M M M – M L M	T T T T T – T L T
	9	M S M M M – M M M	M D M M M – M L M	T T T T T – T L T
	10	M M M M M – M M M	M D M M M – M L M	T T T T T – T L T
	11	M M M M M – M M M	M D M M M – M L M	T T T T T – T L T
CC	15	M S M M M – M M M	M D M M M – M L M	T T T T T – T L T
	16	M [illegible] M M M – M M M	M D M M M – M L M	T T T T T – T L T
	17	M S M M M – M M M	M D M M M – M L M	T T T T T – T L T
	18	M S M M M – M M M	M D M M M – M L M	T T T T T – T L T
DD	25	M M C M C – M M M	M M M M M – M L M	T T T L T – T L T
	26	M M C M C – M M M	M M M M M – M L M	T T T L T – T L T
	27	M M C M C – M M M	M M M M M – M L M	T T T L T – T L T
	28	M M C M C – M M M	M M M M M – M L M	T T T L T – T L T
EE*	11	M M M M M – M M M	M D M M M – D L M	T T T L T – T L T
	12	M M M M M – M M M	M D M M M – D L M	T T T L T – T L T
	13	M M M M M – M M M	M D M M M – D L M	T T T L T – T L T
	14	M M M M M – M M M	M D M M M – D L M	T T T L T – T L T
HH	19	S VS S S S – S M S	M D M M M – D L M	T T T L T – T L T
	20	S VS S S S – S M S	M D M M M – D L M	T T T L T – T L T
	21	S VS S S S – S M S	M D M M M – D L M	T T T L T – T L T
	22	S VS S S S – S M S	M D M M M – D L M	T T T L T – T L T
II	20	S VS M S S – M M S	M D M M M – D L M	T T T T T – T L T
	21	S VS M S S – M M S	M D M M M – D L M	T T T T T – T L T
	22	S VS M S S – M M S	M D M M M – D L M	T T T T T – T L T
	23	S VS M S S – M M S	M D M M M – D L M	T T T T T – T L T
KK	6	S VS M S S – M M M	M D M M M – D L M	T T T T T – T L T
	7	S VS M S S – M M M	M D M M M – D L M	T T T T T – T L T
	8	S VS M S S – M M M	M D M M M – D L M	T T T T T – T L T
	9	S VS M S S – M M M	M D M M M – D L M	T T T T T – T L T
MM*	29	S M M S C – M M M	M D M M M – M L M	T T T T T – T L T
	30	S M M S C – M M M	M D M M M – M L M	T T T T T – T L T
	31	S M M S C – M M M	M D M M M – M L M	T T T T T – T L T
	32	S M M S C – M M M	M D M M M – M L M	T T T T T – T L T
SS	29	C C C C C – C C C	M L L M M – L L M	L L T L L – L L T
	30	C C C C C – C C C	M L L M M – L L M	L L T L L – L L T
	31	C C C C C – C C C	M L L M M – L L M	L L T L L – L L T
	32	C C C C C – C C C	M L L M M – L L M	L L T L L – L L T
TT	29	M S M S S – M M M	M D M M M – M L M	T T T T T – T L T
	30	M S M S S – M M M	M D M M M – M L M	T T T T T – T L T
	31	M S M S S – M M M	M D M M M – M L M	T T T T T – T L T
	32	M S M S S – M M M	M D M M M – M L M	T T T T T – T L T
UU	29	M S M S M – M M M	M M M M M – M L M	T T T T T – T L T
	30	M S M S M – M M M	M M M M M – M L M	T T T T T – T L T
	31	M S M S M – M M M	M M M M M – M L M	T T T T T – T L T
	32	M S M S M – M M M	M M M M M – M L M	T T T T T – T L T
VV	29	M S M C M – M M M	M M M M M – M L M	T T T L T – T L T
	30	M S M C M – M M M	M M M M M – M L M	T T T L T – T L T
	31	M S M C M – M M M	M M M M M – M L M	T T T L T – T L T
	32	M S M C M – M M M	M M M M M – M L M	T T T L T – T L T
XX	29	C C VC C VC – C S C	M M L M M – L L M	L L T L L – L L T
	30	C C VC C VC – C S C	M M L M M – L L M	L L T L L – L L T
	31	C C VC C VC – C S C	M M L M M – L L M	L L T L L – L L T
	32	C C VC C VC – C S C	M M L M M – L L M	L L T L L – L L T
OO	29	C M C M C – C C C	M M M M M – M L M	L L T L L – L L T
	30	C M C M C – C C C	M M M M M – M L M	L L T L L – L L T
	31	C M C M C – C C C	M M M M M – M L M	L L T L L – L L T
	32	C M C M C – C C C	M M M M M – M L M	L L T L L – L L T
CCC	1	M S M M M – M M C	M M M M M – M L M	T T T L T – L L T
	2	M S M M M – M M C	M M M M M – M L M	T T T L T – L L T
	3	M S M M M – M M C	M M M M M – M L M	T T T L T – L L T
	4	M S M M M – M M C	M M M M M – M L M	T T T L T – L L T
ZZ	8	C C VC C C – C M C	M M L L L – M L M	T L T – L – L L T
	10	C C VC C C – C M C	M M L L L – M L M	T L T – L – L L T
	14	C C VC C C – C M C	M M L L L – M L M	T L T – L – L L T
	116	C VS M M M – M S M	M D M M D – D M D	T T T – T – T L T
	310	C VS M M M – M S M	M D D M D – D M D	T T T – T – T L T
	311	C VS M M M – M S M	M D D M D – D M D	T T T – T – T L T

* Open Annealed

ROW No. 2

Mark	Sheet No.	Texture 1 2 3 4 5 6 7 8 9	Color 1 2 3 4 5 6 7 8 9	Adherence 1 2 3 4 5 6 7 8 9
A	31	C VC VC VC VC – VC VC C	M D M L L – L L M	L L L • L – L L L
	32	C VC VC VC VC – VC VC C	M D M L L – L L M	L L L – L – L L L
	33	C VC VC VC VC – VC VC C	M D M L L – L L M	L L L – L – L L L
	34	C VC VC VC VC – VC VC C	M D M L L – L L M	L L L – L – L L L
B	[illegible]	S VS S M M – C M S	D D D M D – M D D	T T T • T – T T T
	[illegible]	S VS S M M – C M S	D D D M D – M D D	T T T – T – T T T
	[illegible]	S VS S M M – C M S	D D D M D – M D D	T T T – T – T T T
	[illegible]	S VS S M M – C M S	D D D M D – M D D	T T T – T – T T T
C	[illegible]	S S M M M – C M M	D D D M M – M M D	T T T • T – T T T
	[illegible]	S S M M M – C M M	D D D M M – M M D	T T T – T – T T T
	[illegible]	S S M M M – C M M	D D D M M – M M D	T T T – T – T T T
	[illegible]	S S M M M – C M M	D D D M M – M M D	T T T – T – T T T
D	30	C C C C VC – C C C	M D M L M – M M D	T L T • L – L L T
	31	C C C C VC – C C C	M D M L M – M M D	T L T – L – L L T
	32	C C C C VC – C C C	M D M L M – M M D	T L T – L – L L T
	33	C C C C VC – C C C	M D M L M – M M D	T L T – L – L L T
E	[illegible]	M S M C M – C M M	D D D M M – L M D	T T T • T – L T T
	[illegible]	M S M C M – C M M	D D D M M – L M D	T T T – T – L T T
	[illegible]	M S M C M – C M M	D D D M M – L M D	T T T – T – L T T
	[illegible]	M S M C M – C M M	D D D M M – L M D	T T T – T – L T T
H	[illegible]	M VS S M M – M S S	D D D M M – M M D	T T T • T – L T T
	[illegible]	M VS S M M – M S S	D D D M M – M M D	T T T – T – L T T
	[illegible]	M VS S M M – M S S	D D D M M – M M D	T T T – T – L T T
	[illegible]	M VS S M M – M S S	D D D M M – M M D	T T T – T – L T T
I	[illegible]	M VS S M M – M S S	M D D M M – D M D	T T T • T – T T T
	[illegible]	M VS S M M – M S S	M D D M M – D M D	T T T – T – T T T
	[illegible]	M VS S M M – M S S	M D D M M – D M D	T T T – T – T T T
	[illegible]	M VS S M M – M S S	M D D M M – D M D	T T T – T – T T T
K	[illegible]	M VS S M M – M S S	M C D M M – M M D	T T T • T – T T T
	[illegible]	M VS S M M – M S S	M C D M M – M M D	T T T – T – T T T
	[illegible]	M VS S M M – M S S	M C D M M – M M D	T T T – T – T T T
	[illegible]	M VS S M M – M S S	M C D M M – M M D	T T T – T – T T T
M	29	M S S M M – M M M	M D D M M – M M D	T T T • T – T L T
	30	M S S M M – M M M	M D D M M – M M D	T T T – T – T L T
	31	M S S M M – M M M	M D D M M – M M D	T T T – T – T L T
	32	M S S M M – M M M	M D D M M – M M D	T T T – T – T L T
N	29	C C C VC VC – VC C C	M M M L L – L L M	L L L • L – L L T
	30	C C C VC VC – VC C C	M M M L L – L L M	L L L – L – L L T
	31	C C C VC VC – VC C C	M M M L L – L L M	L L L – L – L L T
	32	C C C VC VC – VC C C	M M M L L – L L M	L L L – L – L L T
T	29	M VS S M M – M M S	M D D M M – D M D	T T T • T – T T T
	30	M VS S M M – M M S	M D D M M – D M D	T T T – T – T T T
	31	M VS S M M – M M S	M D D M M – D M D	T T T – T – T T T
	32	M VS S M M – M M S	M D D M M – D M D	T T T – T – T T T
U	29	M VS S M M – M M M	M D D M M – M M D	T T T • T – T T T
	30	M VS S M M – M M M	M D D M M – M M D	T T T – T – T T T
	31	M VS S M M – M M M	M D D M M – M M D	T T T – T – T T T
	32	M VS S M M – M M M	M D D M M – M M D	T T T – T – T T T
V	29	M VS S M M – M M M	D D D M M – M M D	T T T • T – T T T
	30	M VS S M M – M M M	D D D M M – M M D	T T T – T – T T T
	31	M VS S M M – M M M	D D D M M – M M D	T T T – T – T T T
	32	M VS S M M – M M M	D D D M M – M M D	T T T – T – T T T
X	29	C VC VC VC VC – VC C VC	M M M M M – L L D	L L T • L – L L T
	30	C VC VC VC VC – VC C VC	M M M M M – L L D	L L T – L – L L T
	31	C VC VC VC VC – VC C VC	M M M M M – L L D	L L T – L – L L T
	32	C VC VC VC VC – VC C VC	M M M M M – L L D	L L T – L – L L T
O	29	C VC VC VC VC – VC VC VC	L M L L M – L L L	L L L • L – L L L
	30	C VC VC VC VC – VC VC VC	L M L L M – L L L	L L L – L – L L L
	31	C VC VC VC VC – VC VC VC	L M L L M – L L L	L L L – L – L L L
	32	C VC VC VC VC – VC VC VC	L M L L M – L L L	L L L – L – L L L
Z	6	C C C VC VC – C C C	M M M L M – M M M	L L L • L – L L T
	7	C C C VC VC – C C C	M M M L M – M M M	L L L – L – L L T
	11	C C C VC VC – C C C	M M M L M – M M M	L L L – L – L L T
	111	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T
	112	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T
	209	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T
	210	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T
	211	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T
	310	M VS VS M M – M S S	M D D M D – D M D	T T T – T – T T T

ROW No. 3

Mark	Sheet No.	Texture 1 2 3 4 5 6 7 8 9	Color 1 2 3 4 5 6 7 8 9	Adherence 1 2 3 4 5 6 7 8 9
AA	25	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L • L – L L L
	26	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L – L – L L L
	27	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L – L – L L L
	28	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L – L – L L L
	29	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L – L – L L L
	30	VC VC VC VC VC – C VC C	L L L L M – L L L	L L L – L – L L L
AA*	50	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L • L – L L L
	51	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
	52	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
	53	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
	54	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
	55	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
	56	VC VC VC VC VC – C VC VC	L L L L M – L L L	L L L – L – L L L
BB	22	M M M M M – M C M	M D D M M – M M D	T T T • T – T L T
	23	M M M M M – M C M	M D D M M – M M D	T T T – T – T L T
	24	M M M M M – M C M	M D D M M – M M D	T T T – T – T L T
	40	M S M M M – M C M	M D D M M – D M D	T T T – T – T L T
	41	M S M M M – M C M	M D D M M – D M D	T T T – T – T L T
EE*	33	M VS M M M – M M M	M D D M M – D M D	T T T • T – T T T
	34	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	35	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	36	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	50	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	51	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	52	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
	53	M VS M M M – M M M	M D D M M – D M D	T T T – T – T T T
CC	7	M S M M M – M C M	M D M M M – M M D	T T T • T – T T T
	10	M S M M M – M C M	M D M M M – M M D	T T T – T – T T T
CC*	31	M S M M M – M C C	M D M M M – M M D	T T T • T – T T T
	32	M S M M M – M C C	M D M M M – M M D	T T T – T – T T T
	33	M S M M M – M C C	M D M M M – M M D	T T T – T – T T T
	34	M S M M M – M C C	M D M M M – M M D	T T T – T – T T T
	35	M S M M M – M C C	M D M M M – M M D	T T T – T – T T T
	36	M S M M M – M C C	M D M M M – M M D	T T T – T – T T T
DD	8	M M C M C – M M C	M D M M M – M M D	T T T • T – T L T
	9	M M C M C – M M C	M D M M M – M M D	T T T – T – T L T
	10	M M C C C – M M C	M D M M M – M M D	T T T – T – T L T
	11	M M C C C – M M C	M D M M M – M M D	T T T – T – T L T
	50	M M C C C – M M C	M D M M M – M M D	T T T – T – T L T
	51	M M C C C – M M C	M D M M M – M M D	T T T – T – T L T
DD*	47	M M C C C – M C M	M D M M M – M M D	T T T • T – T L T
	48	M M C C C – M C M	M D M M M – M M D	T T T – T – T L T
	49	M M C C C – M C M	M D M M M – M M D	T T T – T – T L T
	50	M M C C C – M C C	M D M M M – M M D	T T T – T – T L T
	51	M M C C C – M C C	M D M M M – M M D	T T T – T – T L T
	57	M M C C C – M C C	M D M M M – M M D	T T T – T – T L T
	58	M M C C C – M C C	M D M M M – M M D	T T T – T – T L T
EE†	17	M S M M M – M M M	D D D M M – D M D	T T T • T – T L T
	18	M S M M M – M M M	D D D M M – D M D	T T T – T – T L T
KK*†	31	M S S M M – M M S	D D D M M – D M D	T T T • T – T L T
	32	M S S M M – M M S	D D D M M – D M D	T T T – T – T L T
	33	M S S M M – M M S	D D D M M – D M D	T T T – T – T L T
	34	M S S M M – M M S	D D D M M – D M D	T T T – T – T L T
	35	M S S M M – M M S	D D D M M – D M D	T T T – T – T L T
	36	M S S M M – M M S	D D D M M – D M D	T T T – T – T L T
HH*	23	M VS S S M – M M S	D D D M M – D M D	T T T • T – T L T
	24	M VS S S M – M M S	D D D M M – D M D	T T T – T – T L T
	25	M VS S S M – M M S	D D D M M – D M D	T T T – T – T L T
	26	M VS S S M – M M S	D D D M M – D M D	T T T – T – T L T
HH*	43	M VS S S M – M M S	D D D M M – D M D	T T T • T – T L T
	44	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
	45	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
	46	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
	47	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
	48	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
	49	M VS S S M – M M S	D D D M M – D M D	T T T – T – T T T
II	25	M VS S S M – M S VS	M D D M M – D M D	T T T • T – T T T
	26	M VS S S M – M S VS	M D D M M – D M D	T T T – T – T T T
	27	M VS S S M – M S VS	M D D M M – D M D	T T T – T – T T T
	28	M VS S S M – M S VS	M D D M M – D M B	T T T – T – T T T
	29	M VS S S M – M S VS	M D D M M – D M D	T T T – T – T T T

* Lead Coated
† Open Annealed

ROW No. 4

Mark	Sheet No.	Aupperle	Buck	Cooper
II*	48	M	S	S
	49	M	S	S
	50	M	S	S
	51	M	S	S
	52	M	S	S
	53	M	S	S
	54	M	S	S
	55	M	S	S
	56	M	S	S
KK	28	S	VS	S
	29	S	VS	S
	30	S	VS	S
	31	S	VS	S
	32	S	VS	S
	33	S	VS	S
	34	S	VS	S
KK*	51	M	M	[illegible]
	52	M	M	[illegible]
	53	M	M	[illegible]
	54	M	M	[illegible]
	55	M	M	[illegible]
	56	M	M	[illegible]
	57	M	M	[illegible]
	58	M	M	[illegible]
MM†	33–42	M	M	[illegible]
SS	33–42	C	C	[illegible]
TT	33–42	S	S	[illegible]
VV	41–51	M	S	[illegible]

* Lead Coated
† Open Annealed

CONDITION OF RUST.

Texture	Color	Adherence
VS – Very Smooth	L – Light	T – Tight
S – Smooth	M – Medium	L – Loose
M – Medium	D – Dark	
C – Coarse		
VC – Very Coarse		

— INSPECTION COMMITTEE —

J. H. Gibboney, Chairman – Norfolk & Western Ry. Co.
J. A. Aupperle, – American Rolling Mill Co.
D. M. Buck, – American Sheet & Tin Plate Co.
W. A. Cooper, – Alan Wood Iron & Steel Co.
W. R. Fleming, – The Andrews Steel Co.
D. J. Mc Adam, Jr. – U. S. Navy, Bureau Steam Engineering.
M. E. McDonnell, – Pennsylvania Railroad Co.
H. E. Smith, – New York Central Railroad Co.
F. B. Wheaton, – U. S. Army, Quartermaster's Corps.

— AUPPERLE —
Notes : – None.

Note :
Great [illegible]
will ha[illegible]
Panel "[illegible]
and so[illegible]
Corrod[illegible]
better [illegible]
Masked[illegible]

Design[illegible]

Table II.—Results of Inspection of Corrosion Test Sheets, at Pittsburgh, Pa., Octob[er]

AMERICAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

PITTSBURGH, PA.

EXPOSED DECEMBER 12 1916

Inspectors (columns 1–9 under each of Texture, Color and Adherence): 1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton.

ROW No. 4

Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
II*	48	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	L	T
	49	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	50	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	51	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	52	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	53	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	54	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	55	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
	56	M	S	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	L	T
KK	28	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	29	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	30	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	31	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	32	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	33	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	34	S	VS	S	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
KA*	51	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	L		T	L	T
	52	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	53	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	54	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	55	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	56	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	57	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	58	M	M	S	M	C		M	M	M	M	D	D	M	M		D	M	D	T	T	T		L		T	L	T
MM†	33	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T	•	L		T	L	T
	34	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	35	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	36	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	37	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	38	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	39	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	40	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	41	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
	42	M	M	M	M	C		M	M	C	D	D	D	M	M		D	M	D	T	T	T		L		T	L	T
SS	33	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L	•	L		T	L	T
	34	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	35	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	36	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	37	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	38	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	39	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	40	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	41	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
	42	C	C	C	C	VC		C	C	VC	M	M	M	M	M		M	M	M	L	L	L		L		T	L	T
TT	33	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L	•	T		T	T	T
	34	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	35	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	36	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	37	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	38	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	39	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	40	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	41	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
	42	S	S	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	L		T		T	T	T
UU	33	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T	•	T		T	T	T
	34	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	35	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	36	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	37	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	38	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	39	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	40	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	41	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	42	M	S	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
VV	43	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T	•	T		T	L	T
	44	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	45	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	L	T
	46	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	47	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	48	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	49	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	50	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	51	M	S	M	S	M		M	M	C	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T

ROW No. 5

Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
XX	33	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T	•	T		T	L	T
	34	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	35	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	36	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	37	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	38	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	39	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	40	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	41	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
	42	C	C	C	C	C		C	C	C	M	D	M	M	M		M	M	D	L	L	T		T		T	L	T
ZZ	208	S	VS	VS	M	M		M	VS	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	209	S	VS	VS	M	M		M	VS	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	213	S	VS	VS	M	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	314	S	VS	VS	M	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	415	C	M	C	C	C		C	M	M	M	M	M	M	M		L	M	D	T	L	TL		T		T	T	T
	417	C	M	C	C	C		C	M	M	M	M	M	M	M		L	M	D	T	L	TL		T		T	T	T
	507	C	VS	VS	M	M		M	S	S	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	510	M	VS	VS	S	M		M	S	S	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	509	M	VS	VS	S	M		M	S	S	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	612	M	VS	S	S	M		M	S	S	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	614	M	VS	S	S	M		M	S	S	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	615	M	VS	S	S	M		M	S	M	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	714	M	VS	S	S	M		M	S	M	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
	715	M	VS	S	S	M		M	S	M	M	D	M	M	M		D	M	D	T	T	T		T		T	T	T
OO	29	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T	•	T		T	T	T
	30	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	31	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	32	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	33	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	34	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	35	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
	36	C	M	C	C	C		C	C	C	M	D	M	M	M		M	M	D	T	TL	T		T		T	T	T
CCC	5	S	S	M	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	6	S	S	M	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	7	S	S	M	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	8	S	S	M	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	9	S	S	M	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	10	S	S	M	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	11	S	S	M	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	12	S	S	M	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
A	35	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L	•	L		L	L	T
	36	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	37	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	38	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	39	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	40	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	41	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	42	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	43	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	44	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	45	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	46	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
	47	C	VC	VC	VC	VC		C	C	VC	M	D	M	L	M		M	M	D	L	L	L		L		L	L	T
B	21	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	22	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	23	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	24	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	25	S	VS	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	26	S	VS	S	S	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	27	S	VS	S	S	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	28	S	VS	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
	29	S	VS	S	S	M		M	M	M	D	D	D	M	M		M	M	D	T	T	T		T		T	T	T
C	29	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	30	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	31	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	32	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	33	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	34	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	S	VS	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T

ROW No. 6

Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
D	35	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T	•	T		T	T	T
	36	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	38	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	39	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	40	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
K	29	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	30	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	31	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	32	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	33	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	34	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
M	63	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	65	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	67	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	69	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	50	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	53	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	54	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	55	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	43	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	44	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	45	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	46	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	47	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	48	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	49	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	50	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	51	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	52	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	53	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	54	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	55	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
K	37	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	38	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	43	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	44	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	45	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	46	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	47	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	48	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
M	33	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	34	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	37	M	S	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	38	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	33	M	C	C	C	VC		C	C	C	M	D	M	M	M		M	M	D	T	L	L	•	T		L	T	T
	34	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	35	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	36	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	37	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	38	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	39	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	40	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	41	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	42	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T

ROW No. 7

Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9
T	33	M	VS	S	S	M		M	M	S
	34	M	VS	S	S	M		M	M	S
	35	M	VS	S	S	M		M	M	S
	36	M	VS	S	S	M		M	M	S
	37	M	VS	S	S	M		M	M	S
	38	M	VS	S	S	M		M	M	S
	39	M	VS	S	S	M		M	M	S
	40	M	VS	S	S	M		M	M	S
	41	M	VS	S	S	M		M	M	S
	42	M	VS	S	S	M		M	M	S
U	33	M	VS	S	S	M		M	M	[illegible]
	34	M	VS	S	S	M		M	M	[illegible]
	35	M	VS	S	S	M		M	M	[illegible]
	36	M	VS	S	S	M		M	M	[illegible]
	37	M	VS	S	S	M		M	M	[illegible]
	38	M	VS	S	S	M		M	M	[illegible]
	39	M	VS	S	S	M		M	M	[illegible]
	40	M	VS	S	S	M		M	M	[illegible]
	41	M	VS	S	S	M		M	M	[illegible]
	42	M	VS	S	S	M		M	M	[illegible]
V	33	M	VS	S	S	M		M	M	[illegible]
	34	M	VS	S	S	M		M	M	[illegible]
	35	M	VS	S	S	M		M	M	[illegible]
	36	M	VS	S	S	M		M	M	[illegible]
	37	M	VS	S	S	M		M	M	[illegible]
	38	M	VS	S	S	M		M	M	[illegible]
	39	M	VS	S	S	M		M	M	[illegible]
	40	M	VS	S	S	M		M	M	[illegible]
	41	M	VS	S	S	M		M	M	[illegible]
	42	M	VS	S	S	M		M	M	[illegible]
X	33	C	C	VC	VC	VC		C	C	C
	34	C	C	VC	VC	VC		C	C	C
	35	C	C	VC	VC	VC		C	C	C
	36	C	C	VC	VC	VC		C	C	C
	37	C	C	VC	VC	VC		C	C	C
	38	C	C	VC	VC	VC		C	C	C
	39	C	C	VC	VC	VC		C	C	C
	40	C	C	VC	VC	VC		C	C	VC
	41	C	C	VC	VC	VC		C	C	VC
	42	C	C	VC	VC	VC		C	C	VC
Z	111	S	VS	VS	S	S		M	S	VS
	422	C	C	C	C	C		C	C	C
	423	C	C	C	C	C		C	C	C
	424	C	C	C	C	C		C	C	C
	508	M	VS	VS	S	M		M	S	M
	513	M	VS	VS	S	M		M	S	M
	516	M	VS	VS	S	M		M	S	[illegible]
	607	M	VS	VS	S	M		M	S	S
	608	M	VS	VS	S	M		M	S	S
	609	M	VS	VS	S	M		M	S	S
	712	M	VS	VS	S	M		M	S	S
	714	M	VS	VS	S	M		M	S	S
	715	M	VS	VS	S	M		M	S	S
O	29	C	VC	VC	VC	VC		VC	C	[illegible]
	30	C	VC	VC	VC	VC		VC	C	[illegible]
	31	C	VC	VC	VC	VC		VC	C	[illegible]
	32	C	VC	VC	VC	VC		VC	C	[illegible]
	33	C	VC	VC	VC	VC		VC	C	[illegible]
	34	C	VC	VC	VC	VC		VC	C	[illegible]
	35	C	VC	VC	VC	VC		VC	C	[illegible]
	36	C	VC	VC	VC	VC		VC	C	[illegible]
Y*	7	M	M	M		C		M		[illegible]
	8	M	M	M		C		M		[illegible]
	9	M	M	M		C		M		[illegible]
YY*	7	M	C	M		C		M		[illegible]
	8	M	C	M		C		M		[illegible]
	9	M	C	M		C		M		[illegible]

*[illegible]

†[illegible]

* [illegible]

—BUCK—

Note:—Corrosion of some Grades Proceeding with Great Rapidity, and it is Predicted that Certain Panels will have Completely Failed before the Spring Inspection. Panel "O" will probably be First to Fail, followed by A, S, X and some of Z. Similar Grades in 16 Gage are also Corroding Fast, although Panel OO is in relatively better Condition than O.—Color Values somewhat Masked by Soot and Dirt.

Designation Mark "TL" indicates Medium Adherence.

—COOPER—

Note:—Designation Mark "TL" indicates Medium Adherence.

A 31 to 34 inc.	Sheets very thin.	
S 29 " 32 "	" thin.	
O 25 " 28 "	" very thin.	
Z 111, 112 & 113.	Good Surface.	
A 35 to 47 inc.	Sheets very thin, Bent Corners.	
O 29 " 36 "	Sheets very thin.	
Y* 7 " 9 "	Mill Scale on.	
YY* 7 " 9 "		

—FLEMING—

S 29 to 32 inc. Early Failure.
O 29 " 36 " " "
Y* Not Inspected.
YY* " " .
• Designation not Shown.

—GIBBONEY—

A 31 to 34 inc. Sheets thin.
S 29 " 32 " Near Failure.
O 25 " 28 " " " .
A 35 " 47 " Sheets thin.
O 29 " 36 " Near Failure.

…F CORROSION TEST SHEETS, AT PITTSBURGH, PA., OCTOBER 9, 1917.

…CAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

PITTSBURGH, PA.

EXPOSED DECEMBER 12 1916

Weather *Cold and*…

…UST

Color 7 McDonnell	Color 8 Smith	Color 9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
M	M	D	L	L	T	•	T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
M	M	D	L	L	T		T		T	L	T
D	M	D	T	T	T	•	T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
L	M	D	T	L	T		T		T	T	T
L	M	D	T	L	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
D	M	D	T	T	T		T		T	T	T
M	M	D	T	L	T	•	T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
M	M	D	T	L	T		T		T	T	T
	M	D	T	T	T	•	T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	T	T	T		T		T	T	T
	M	D	L	L	L	•	L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
	M	D	L	L	L		L		L	L	T
		D	T	T	T	•	T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T	•	T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T
		D	T	T	T		T		T	T	T

ROW No. 6

CONDITION OF RUST — Texture / Color / Adherence (1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton)

Designation Mark	Sheet No.	Tex. 1	2	3	4	5	6	7	8	9	Col. 1	2	3	4	5	6	7	8	9	Adh. 1	2	3	4	5	6	7	8	9
[illegible]	[illegible]	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T	•	T		T	T	T
	[illegible]	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	[illegible]	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	[illegible]	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
	[illegible]	M	M	M	M	C		M	M	M	M	D	M	M	M		M	M	D	T	T	T		T		T	T	T
[illegible]	29	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	30	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	31	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	32	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	33	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	34	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	S	M	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
[illegible]	43	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	45	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	47	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	49	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	50	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	53	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	54	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	55	M	VS	S	VS	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	42	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	44	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	45	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	46	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	47	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	48	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	49	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	50	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	51	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	52	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	53	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	54	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	55	S	VS	S	S	M		M	S	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
[illegible]	37	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	38	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	43	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	44	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	45	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	46	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	47	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	48	S	VS	S	S	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
[illegible]	33	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	34	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	37	M	S	S	M	M		M	M	M	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	38	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	M	S	S	M	M		M	M	S	D	D	D	M	M		D	M	D	T	T	T		T		T	T	T
[illegible]	33	M	C	C	C	VC		C	C	C	M	D	M	M	M		M	M	D	T	L	L	•	T		L	T	T
	34	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	35	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	36	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	37	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	38	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	39	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	40	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	41	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T
	42	M	C	C	C	VC		C	C	C	M	D	M	M	M		L	M	M	T	L	L		T		L	T	T

ROW No. 7

CONDITION OF RUST — Texture / Color / Adherence (1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton)

Designation Mark	Sheet No.	Tex. 1	2	3	4	5	6	7	8	9	Col. 1	2	3	4	5	6	7	8	9	Adh. 1	2	3	4	5	6	7	8	9
T	33	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	34	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	37	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	38	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
U	33	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	34	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	37	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	38	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	M	VS	S	S	M		M	M	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
V	33	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	34	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	35	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	36	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	37	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	38	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	39	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	40	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	41	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	42	M	VS	S	S	M		M	M	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
X	33	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L	•	T		L	T	T
	34	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	35	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	36	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	37	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	38	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	39	C	C	VC	VC	VC		C	C	C	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	40	C	C	VC	VC	VC		C	C	VC	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	41	C	C	VC	VC	VC		C	C	VC	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
	42	C	C	VC	VC	VC		C	C	VC	M	D	M	M	M		M	M	D	L	L	L		T		L	T	T
S	314	S	VS	VS	S	S		M	S	VS	D	D	D	M	M		D	M	D	T	T	T	•	T		T	T	T
	422	C	C	C	C	C		C	C	C	D	D	M	M	M		M	M	D	L	L	L		L		T	T	T
	423	C	C	C	C	C		C	C	C	D	D	M	M	M		M	M	D	L	L	L		L		T	T	T
	424	C	C	C	C	C		C	C	C	D	D	M	M	M		M	M	D	L	L	L		L		T	T	T
	509	M	VS	VS	S	M		M	S	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	513	M	VS	VS	S	M		M	S	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	516	M	VS	VS	S	M		M	S	M	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	607	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	608	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	609	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	712	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	714	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	715	M	VS	VS	S	M		M	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
O	29	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L	•	L		L	L	T
	30	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	31	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	32	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	33	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	34	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	35	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
	36	C	VC	VC	VC	VC		VC	C	VC	L	M	L	M	L		L	M	M	L	L	L		L		L	L	T
Y*	7	M	M	M		C		M		VS	M	D	M		M		L		D	L	L	T	•	T		T		T
	8	M	M	M		C		M		VS	M	D	M		M		L		D	L	L	T		T		T		T
	9	M	M	M		C		M		VS	M	D	M		M		L		D	L	L	T		T		T		T
YY*	7	M	C	M		C		M		VS	M	D	M		M		L		D	L	L	T	•	T		L		T
	8	M	C	M		C		M		VS	M	D	M		M		L		D	L	L	T		T		L		T
	9	M	C	M		C		M		VS	M	D	M		M		L		D	L	L	T		T		L		T

* Exposed 6-1917

…ndicates Medium

…

Bent Corners.

— FLEMING —

S 29 to 32 inc. Early Failure.

O 29 " 36 " " "

Y* Not Inspected.

YY* " " .

• Designation not Shown.

— GIBBONEY —

A 31 to 34 inc. Sheets thin.

S 29 " 32 " Near Failure.

O 25 " 28 " " " .

A 35 " 47 " Sheets thin.

O 29 " 36 " Near Failure.

— MC ADAM —

Did not Make this Inspection.

AA 21 to 24 inc.

OO 25 " 28 "

CCC 1 " 4 "

A 31 " 34 "

S 29 " 32 "

X 29 " 32 "

O 25 " 28 "

AA 25 " 30 "

AA* 50 " 56 "

XX 33 " 42 "

OO 29 " 36 "

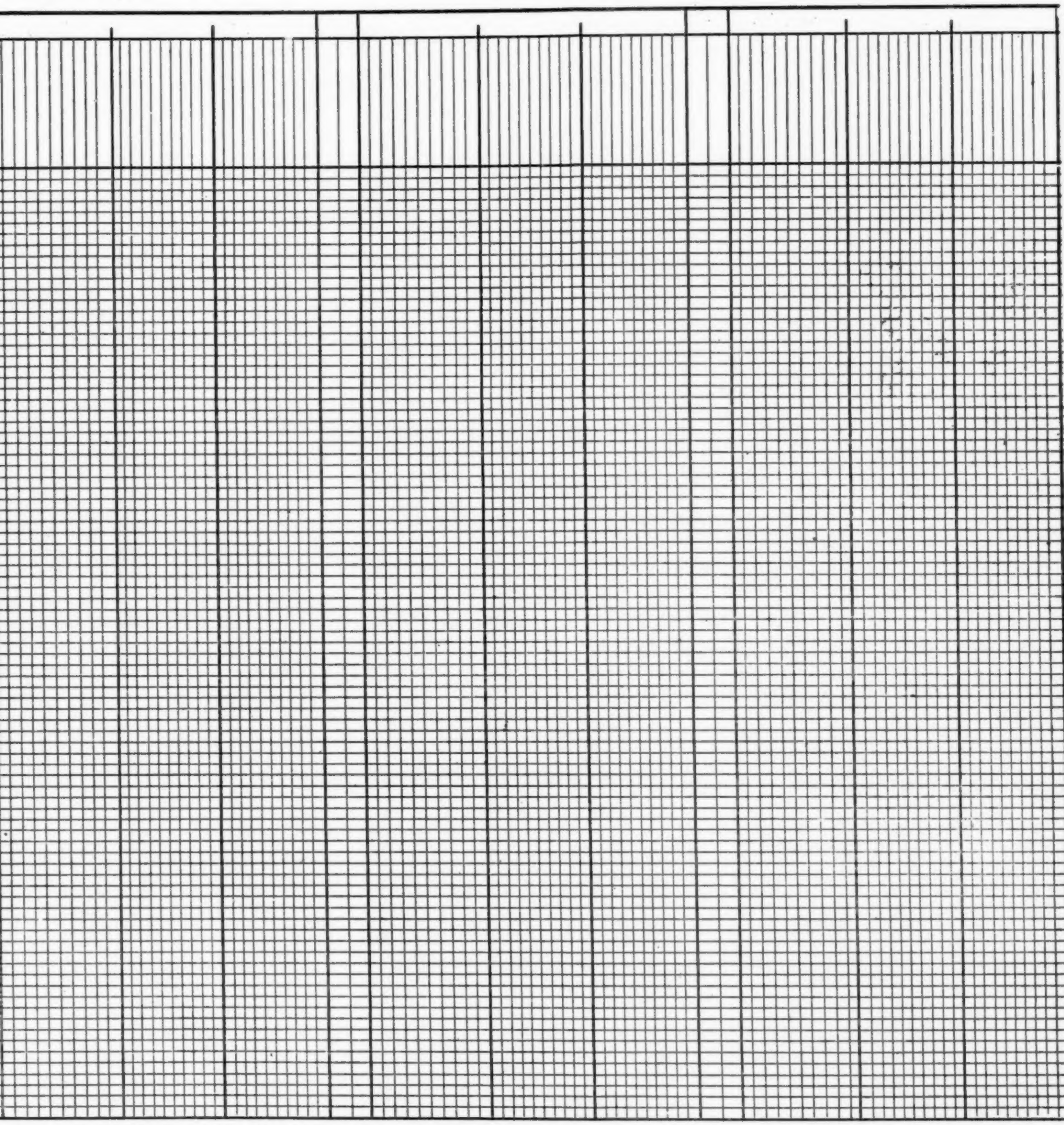
A 35 " 47 "

S 33 " 42 "

X 33 " 42 "

PLATE II.
PROC. AM. SOC. TEST. MATS.
VOL. XVIII, PART I.
REPORT OF COMMITTEE A-5:
CORROSION TESTS.

...old and Cloudy...



— McDONNELL —

AA 21 to 24 inc. Badly Rusted, 50%   Z 422, 423 & 424 rather badly Rusted.
OO 25 " 28 " " " 60%
CCC 1 " 4 " Adherence Medium.
A 31 " 34 " Badly Rusted 50%
S 29 " 32 " " " 50%
X 29 " 32 " " " 50%
O 25 " 28 " " " 40%
AA 25 " 30 " Coarse to very Coarse.
AA* 50 " 56 " " " " "
XX 33 " 42 " Adherence Medium.
OO 29 " 36 " Badly Rusted.
A 35 " 47 " " " 50%, Color Medium to Light.
S 33 " 42 " " " 50%
X 33 " 42 " " " 50%

— SMITH —

D 30 Some Scaling.
OO 29, 30, 33, 34, 35 & 36 Some Scaling.
S 34 Heavy Scales, – there were some Patches of Rust Coming off in Large Scales, but the Remainder was Tight.
O 29 Very Heavy Scales.

— WHEATON —

AA 21 to 23 inc. Scale 10%; – 24 Scale 40%.
SS 29 " 32 " Small Amount of Scale.
OO 25 " 28 " Slight Scale.
D 30 " 34 " Trace of Scale.
S 29 " 32 " Scale 30%
X 29 " 32 " Trace of Scale.
O 25 " 28 " Scale 50%
AA 25 " 30 " " 60%
AA* 50 " 56 " " 40%
DD* 47 " 58 " Trace of Scale.
MMf 33 " 42 " " " "
SS 40 to 42 inc. Scale 20%
XX 33 " 42 " Trace of Scale.
A 35 " 47 " " " "
D 35 " 40 " " " "
S 33 " " "
S 34 " 41 " Scale 40%
S 42 Scale 20%
X 33 " 42 " Spotty.
Y* 7 " 9 " Scale Starting.
SS 33 - Scale 10%, 34 - 5%, 35 - 3%, 36 & 37 - 20%, 38 & 39 - 10%
O 29 & 30 - Scale 10%, O 31 - 20%, 32 to 34 - 40%, 35 - 20%, 36 - 10%

Jas. F. Gibbons, Chairman Inspection Committee

Date of Inspection Oct. 10. 1917.

ROW No. 1

Designation		Condition of Rust — Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	1	C	VC	VC	VC	C	C	C	VC	C	L	L	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	T
	2	C	VC	VC	VC	C	C	C	VC	C	L	L	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	T
	3	C	VC	VC	VC	C	C	C	VC	C	L	L	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	T
BB	1	M	M	C	C	M	C	C	C	M	M	D	M	D	M	D	D	M	D	T	TL	T	L	T	L	T	L	T
	2	M	M	C	C	M	C	C	C	M	M	D	M	D	M	D	D	M	D	T	TL	T	L	T	L	T	L	T
	3	M	M	C	C	M	C	C	C	M	M	D	M	D	M	D	D	M	D	T	TL	T	L	T	L	T	L	T
CC	1	M	M	M	M	M	C	C	VC	C	M	L	M	M	M	L	M	L	M	T	TL	T	L	T	L	T	L	T
	2	M	M	M	M	M	C	C	VC	C	M	L	M	M	M	L	M	L	M	T	TL	T	L	T	L	T	L	T
	3	M	M	M	M	M	C	C	VC	C	M	L	M	M	M	L	M	L	M	T	TL	T	L	T	L	T	L	T
DD	1	M	M	M	M	M	C	C	C	C	M	M	M	M	M	L	M	L	M	T	TL	T	L	T	T	T	T	T
	2	M	M	M	M	M	C	C	C	C	M	M	M	M	M	L	M	L	M	T	TL	T	L	T	T	T	T	T
	3	M	M	M	M	M	C	C	C	C	M	M	M	M	M	L	M	L	M	T	TL	T	L	T	T	T	T	T
EE*	1	M	M	M	M	M	M	C	C	C	M	M	M	M	M	L	M	L	L	T	TL	T	L	T	T	T	L	T
	2	M	M	M	M	M	M	C	C	C	M	M	M	M	M	L	L	L	L	T	TL	T	L	T	T	T	L	T
	3	M	M	M	M	M	M	C	C	C	M	M	M	M	M	L	M	L	L	T	TL	T	L	T	T	T	L	T
HH	1	M	S	S	M	M	M	C	C	S	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	L	T
	2	M	S	S	M	M	M	C	C	M	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	L	T
	3	M	S	S	M	M	M	C	C	M	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	L	T
II	1	S	VS	S	M	S	M	C	M	S	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	T	T
	2	S	VS	S	M	S	M	C	M	S	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	T	T
	3	S	VS	S	M	S	M	C	M	S	M	D	D	D	D	D	D	M	D	T	T	T	T	T	T	T	T	T
KK	1	S	S	S	M	S	M	C	M	S	M	D	D	D	D	D	D	D	D	T	T	T	T	T	T	T	T	T
	2	S	S	S	M	S	M	C	M	S	M	D	D	D	D	D	D	D	D	T	T	T	T	T	T	T	T	T
	3	S	S	S	M	S	M	C	M	S	M	D	D	D	D	D	D	D	D	T	T	T	T	T	T	T	T	T
MM*	1	S	M	S	M	M	C	C	C	M	M	D	D	D	M	D	M	M	D	T	TL	T	T	T	T	T	T	T
	2	S	M	S	M	M	C	C	C	M	M	D	D	D	M	D	M	M	D	T	TL	T	T	T	T	T	T	T
	3	S	M	S	M	M	C	C	C	M	M	D	D	D	M	D	M	M	D	T	TL	T	T	T	T	T	T	T
NN	1	M	M	S	C	C	C	C	C	C	M	L	L	L	L	L	L	L	L	T	TL	T	L	L	L	L	L	T
	2	M	M	S	C	C	C	C	C	C	M	L	L	L	L	L	L	L	L	T	TL	T	L	L	L	L	L	T
	3	M	M	S	C	C	C	C	C	C	M	L	L	L	L	L	L	L	L	T	TL	T	L	L	L	L	L	T
TT	1	M	S	S	M	M	M	C	M	M	M	D	D	D	D	D	D	M	D	T	TL	T	T	T	T	T	T	T
	2	M	S	S	M	M	M	C	M	M	M	D	D	D	D	D	D	M	D	T	TL	T	T	T	T	T	T	T
	3	M	S	S	M	M	M	C	M	M	M	D	D	D	D	D	D	M	D	T	TL	T	T	T	T	T	T	T
UU	1	M	S	S	M	C	M	C	M	M	M	D	D	M	M	M	M	M	M	T	TL	T	L	L	L	T	T	T
	2	M	S	S	M	C	M	C	M	M	M	D	D	M	M	M	M	M	M	T	TL	T	L	L	L	T	T	T
	3	M	S	S	M	C	M	C	M	M	M	D	D	M	M	M	M	M	M	T	TL	T	L	L	L	T	T	T
VV	1	M	M	S	C	C	M	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
	2	M	M	S	C	C	M	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
	3	M	M	S	C	C	M	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
XX	1	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
	2	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
	3	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	TL	T	L	L	L	T	L	T
OO	1	M	M	M	C	C	M	C	C	M	M	D	D	D	M	D	M	M	D	T	TL	T	L	L	L	T	T	T
	2	M	M	M	C	C	M	C	C	M	M	D	D	D	M	D	M	M	D	T	TL	T	L	L	L	T	T	T
	3	M	M	M	C	C	M	C	M	M	M	D	D	D	M	D	M	M	D	T	TL	T	L	L	L	T	T	T
QQ*	22	M	M	M	M	M	M	C	M	M	M	M	M	M	M	L	L	M	M	T	TL	T	T	L	L	T	T	T
	[illegible]	M	M	M	M	M	M	C	M	M	M	M	M	M	M	L	L	M	M	T	TL	T	T	L	L	T	T	T
	27	M	M	M	M	M	M	C	M	M	M	M	M	M	M	L	L	M	M	T	TL	T	T	L	L	T	T	T

ROW No. 2

Designation		Condition of Rust — Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
A	1	C	C	C	C	C	M	C	C	M	M	M	M	M	M	M	M	M	M	L	L	TL	L	L	T	T	L	T
	2	C	C	C	C	C	M	C	C	M	M	M	M	M	M	M	M	M	M	L	L	TL	L	L	T	T	L	T
	3	C	C	C	C	C	M	C	C	M	M	M	M	M	M	M	M	M	M	L	L	TL	L	L	T	T	L	T
B	1	M	S	M	C	C	M	C	C	S	M	D	M	M	M	M	D	M	M	T	TL	T	L	T	T	T	L	T
	2	M	S	M	C	C	M	C	C	S	M	D	M	M	M	M	D	M	M	T	TL	T	L	T	T	T	L	T
	3	M	S	M	C	C	M	C	C	S	M	D	M	M	M	M	D	M	M	T	TL	T	L	T	T	T	L	T
C	1	M	M	M	M	C	M	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	T	L	T	T	L	T
	2	M	M	M	M	C	M	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	T	L	T	T	L	T
	3	M	M	M	M	C	M	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	T	L	T	T	L	T
D	1	M	C	M	C	C	C	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	L	T	L	T	L	T
	2	M	C	M	C	C	C	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	L	T	L	T	L	T
	3	M	C	M	C	C	C	C	C	M	M	L	M	M	L	L	M	M	L	T	L	T	L	T	L	T	L	T
E	1	M	M	C	C	M	M	C	VC	M	M	D	M	L	M	L	M	M	M	T	TL	TL	L	T	T	T	L	T
	2	M	M	C	C	M	M	C	VC	M	M	D	M	L	M	L	M	M	M	T	TL	TL	L	T	T	T	L	T
	3	M	M	C	C	M	M	C	VC	M	M	D	M	L	M	L	M	M	M	T	TL	TL	L	T	T	T	L	T
H	1	M	S	M	M	M	S	C	C	S	M	D	D	D	D	D	M	D	D	T	T	T	T	T	T	T	L	T
	2	M	S	M	M	M	S	C	C	S	M	D	D	D	D	D	M	D	D	T	T	T	T	T	T	T	L	T
	3	M	S	M	M	M	S	C	C	S	M	D	D	D	D	D	M	D	D	T	T	T	T	T	T	T	L	T
I	1	M	VS	S	M	S	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
	2	M	VS	S	M	S	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
	3	M	VS	S	M	S	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
K	1	M	VS	VS	M	M	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
	2	M	VS	VS	M	M	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
	3	M	VS	VS	M	M	S	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	L	T	T	T	L	T
M	1	M	M	M	M	C	M	C	C	M	M	D	M	D	D	M	M	M	D	T	TL	T	•	L	T	T	L	T
	2	M	M	M	M	C	M	C	C	M	M	D	M	D	D	M	M	M	D	T	TL	T		L	T	T	L	T
	3	M	M	M	M	C	M	C	C	M	M	D	M	D	D	M	M	M	D	T	TL	T		L	T	T	L	T
N	1	M	C	M	M	C	M	C	C	M	M	L	L	L	L	L	M	D	L	T	L	T	•	L	T	T	L	TL
	2	M	C	M	M	C	M	C	C	M	M	L	L	L	L	L	M	D	L	T	L	T		L	T	T	L	TL
	3	M	C	M	M	C	M	C	C	M	M	L	L	L	L	L	M	D	L	T	L	T		L	T	T	L	TL
T	1	M	S	M	M	M	M	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T	•	L	T	T	L	T
	2	M	S	M	M	M	M	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T		L	T	T	L	T
	3	M	S	M	M	M	M	C	C	S	M	D	D	D	D	D	D	D	D	T	T	T		L	T	T	L	T
U	1	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	TL	T	•	T	L	T	L	T
	2	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	3	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
V	1	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	T	T	•	T	T	T	L	T
	2	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	T	T		T	T	T	L	T
	3	M	S	M	M	M	M	C	C	M	M	D	M	M	M	M	M	M	M	T	T	T		T	T	T	L	T
X	1	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	L	T	•	L	T	T	L	L
	2	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	L	T		L	T	T	L	L
	3	M	M	M	C	C	C	C	C	C	M	D	M	M	M	M	M	M	M	T	L	T		L	T	T	L	L
O	1	M	C	C	M	VC	C	C	VC	M	M	M	M	D	D	L	L	M	D	T	L	TL	•	L	L	L	L	L
	2	M	C	C	M	VC	C	C	VC	M	M	M	M	D	D	L	M	M	D	T	L	TL		L	L	T	L	L
	3	M	C	C	M	VC	C	C	VC	M	M	M	M	D	D	L	M	M	D	T	L	TL		L	L	T	L	L
Z	1	C	C	C	C	M	C	C	C	M	L	M	M	L	D	L	L	M	D	L	L	T	•	L	L	L	L	L
	2	M	C	C	C	M	C	C	C	M	M	M	M	D	D	L	M	M	D	T	L	T		L	L	T	L	T
	3	M	C	C	C	M	C	C	C	M	M	M	M	D	D	L	M	M	D	T	L	T		L	L	T	L	T

ROW No. 3

Designation		Condition of Rust — Texture									Color									Adherence								
Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	4	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L	•	L	L	L	L	TL
	5	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L		L	L	L	L	TL
	6	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L		L	L	L	L	TL
	7	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L		L	L	L	L	TL
	8	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L		L	L	L	L	TL
	9	C	VC	C	C	VC	VC	C	C	C	L	L	M	L	L	L	L	L	L	L	L	L		L	L	L	L	TL
AA*	31	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T	•	L	L	T	L	TL
	32	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	33	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	34	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	35	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	36	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	37	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	38	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
	39	M	VC	M	C	VC	VC	C	M	C	M	M	M	M	M	L	M	M	M	T	L	T		L	L	T	L	TL
BB	10	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T	•	L	T	T	L	T
	11	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T		L	T	T	L	T
	12	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T		L	T	T	L	T
	13	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T		L	T	T	L	T
	14	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T		L	T	T	L	T
	37	S	M	M	C	C	M	C	M	M	M	M	M	D	D	D	D	M	D	T	TL	T		L	T	T	L	T
BB*	25	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T	•	L	T	T	L	T
	26	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	27	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	28	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	42	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	43	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	44	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
	45	S	M	M	M	C	S	M	S	M	M	D	D	D	D	D	D	D	D	T	TL	T		L	T	T	L	T
CC	5	M	M	M	M	C	M	C	C	C	L	L	M	M	L	M	L	L	L	T	TL	T	•	L	L	T	L	T
	6	M	M	M	M	C	M	C	C	C	L	L	M	M	L	M	L	L	L	T	TL	T		L	L	T	L	T
	8	M	M	M	M	C	M	C	C	C	L	L	M	M	L	M	L	L	L	T	TL	T		L	L	T	L	T
CC*	20	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T	•	T	L	T	L	T
	21	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T		T	L	T	L	T
	22	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T		T	L	T	L	T
	23	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T		T	L	T	L	T
	24	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T		T	L	T	L	T
	25	M	M	S	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	T	TL	T		T	L	T	L	T
DD	[illegible]	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T	•	L	L	T	L	T
	11	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T		L	L	T	L	T
	12	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T		L	L	T	L	T
	13	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T		L	L	T	L	T
	14	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T		L	L	T	L	T
	15	M	C	M	C	C	M	C	C	C	M	L	M	L	M	M	M	L	M	T	TL	T		L	L	T	L	T
DD*	32	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T	•	T	L	T	L	T
	33	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	34	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	35	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	36	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	37	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	38	S	M	M	M	M	M	M	M	M	D	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T

* Open Annealed.

† Exposed 11-30-16.

* Sand Blasted

CONDITION OF RUST.

Texture: VS — Very Smooth; S — Smooth; M — Medium; C — Coarse; VC — Very Coarse

Color: L — Light; M — Medium; D — Dark

Adherence: T — Tight; L — Loose

— INSPECTION COMMITTEE —

J. H. Gibboney, Chairman — Norfolk & Western Ry. Co.
J. A. Aupperle, — American Rolling Mill Co.
D. M. Buck, — American Sheet & Tin Plate Co.
W. A. Cooper, — Alan Wood Iron & Steel Co.
W. R. Fleming, — The Andrews Steel Co.
D. J. McAdam, Jr. — U. S. Navy, Bureau Steam Engineering.
M. E. McDonnell, — Pennsylvania Railroad Co.
H. E. Smith, — New York Central Railroad Co.
F. B. Wheaton, — U. S. Army, Quartermaster's Corps.

— AUPPERLE —
Notes: — None.

— BUCK —
Notes: "TL" indicates Med
All Grades Coarser than at
Same Date, — Difficult to Gr
indicate Early Failure.
Weeds and Brush Should be
Sept. 15, each Year.

TABLE III.—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT ANNAPOLIS, MARY[LAND]

AMERICAN SOCIETY FOR TESTING MATERIALS
COMMITTEE A-5 ON CORROSION OF IRON AND STEEL
TESTS OF UNCOATED SHEETS
ANNAPOLIS, MARYLAND

EXPOSED OCTOBER 17 1916

Inspectors: 1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton.

ROW No. 4

Designation: Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
DD•	41	S	M	S	M	M	S	M	M	C	D	M	M	M	M	L	M	M	M	T	TL	T	•	T	T	T	L	T
	42	S	M	S	M	M	S	M	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		T	T	T	L	T
	43	S	M	S	M	M	S	M	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		T	T	T	L	T
EE†	4	M	M	C	C	D	C	M	C	C	M	M	M	M	M	L	M	M	M	T	TL	TL	•	L	L	T	L	T
	5	M	M	C	C	D	C	M	C	C	M	M	M	M	M	L	M	M	M	T	TL	TL		L	L	T	L	T
	6	M	M	C	C	D	C	M	C	C	M	M	M	M	M	L	M	M	M	T	TL	TL		L	L	T	L	T
ZZ•	19	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T	•	T	T	T	L	T
	20	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
	21	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
	22	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
	23	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
	24	M	M	M	M	C	M	M	M	M	D	D	M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
HH	4	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T	•	T	T	T	L	T
	5	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
	6	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
	7	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
	8	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
	9	S	S	M	M	M	S	M	M	S	D	D	M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
HH•	27	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T	•	T	T	T	T	T
	28	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
	29	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
	30	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
	31	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
	32	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
	33	S	S	S	M	M	S	M	S	S	D	D	D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
II	4	S	S	S	C	M	M	M	M	M	D	M	M	M	D	M	D	M	D	T	TL	T	•	L	T	T	L	T
	5	S	S	S	C	M	M	M	M	M	D	M	M	M	D	M	D	M	D	T	TL	T		L	T	T	L	T
	6	S	S	S	C	M	M	M	M	M	D	M	M	M	D	M	D	M	D	T	TL	T		L	T	T	L	T
	7	S	S	S	C	M	M	M	M	M	D	M	M	M	D	M	D	M	D	T	T	T		L	T	T	L	T
	8	S	S	S	C	M	M	M	M	M	D	M	M	M	D	M	D	M	D	T	T	T		L	T	T	L	T
II•	30	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T	•	T	T	T	T	T
	31	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	32	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	33	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	34	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	35	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	36	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
	37	S	S	S	M	M	VS	M	S	S	D	D	D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
KK	9	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T	•	T	T	T	L	T
	10	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
	11	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
	12	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
	13	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
	14	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
	15	M	S	S	C	M	S	C	M	M	M	M	M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
KK•	35	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T	•	T	T	T	T	T
	36	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
	37	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
	38	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
	39	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
	40	S	S	VS	M	M	VS	M	S	S	D	M	D	D	D	M	D	D	D	T	T	T		T	T	T	T	T

ROW No. 5

Designation: Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
KK•	41	S	S	S	M	C	VS	M	S	S	D	D	D	VD	D	D	D	D	D	T	T	T	•	T	T	T	T	T
	42	S	S	S	M	C	VS	M	S	S	D	D	D	VD	D	D	D	D	D	T	T	T		T	T	T	T	T
MM†	4	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T	•	L	T	T	T	T
	5	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	6	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	7	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	8	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	9	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	10	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	11	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	12	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	TL
	13	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	14	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
SS	4	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T	•	L	L	T	L	TL
	5	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	6	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	7	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	8	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	9	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	10	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	11	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	12	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	13	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	14	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
TT	4	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T	•	T	T	T	L	T
	5	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	6	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	7	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	8	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	9	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	10	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	11	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	12	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	13	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	14	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
UU	4	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T	•	L	T	T	L	T
	5	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	6	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	7	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	8	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	9	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	10	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	11	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	12	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	13	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	14	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
VV	4	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T	•	L	L	T	L	T
	5	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T		L	L	T	L	T
	6	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T		L	L	T	L	T

ROW No. 6

Designation: Mark	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
VV	7	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T	•	L	T	T	L	T
	8	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	9	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	10	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	11	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	12	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	13	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	14	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
XX	4	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T	•	L	L	T	L	T
	5	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	6	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	7	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	8	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	9	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	10	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	11	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	12	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	13	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	14	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
ZZ	1	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T	•	L	L	T	L	T
	2	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T		L	L	T	L	T
	1	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T		L	L	T	L	T
	307	S	S	M	M	M	M	M	M	M	D	D	M	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	301	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	302	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	303	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	201	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	202	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	204	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	206	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	602	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		L	T	T	L	T
	605	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		L	T	T	L	T
	710	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	711	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	102	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	103	S	S	S	M	M	M	M	M	M	D	D	D	D	M	D	M	M	D	T	TL	T		T	T	T	L	T
	417	S	M	M	M	C	M	M	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
	418	S	M	M	M	C	M	C	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
	419	S	M	M	M	C	M	C	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
OO	4	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT	•	L	L	T	L	T
	5	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	6	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	7	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	8	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	9	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	10	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	11	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	12	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T

— [BU]CK —
[...] indicates Medium Adherence.
[...]ser than at Fort Sheridan at
[...]ifficult to Grade. No Panels
[...] Failure.
[...]h Should be Cut down about
[...] Year.

— COOPER —
Notes: — OO 12 – Three Scabs.

— FLEMING —
Notes: — T 1 to 3 inc.
Shrubbery had Shaded Lower 20% of Sheets
which were badly Discolored.
U 1-3 inc. Lower Ends Discolored by Shrubbery
but not as much as "T's"
X 1 to 3 inc. Badly Discolored by Shrubbery, like "T" & "U".
OO 12, – 3 Blisters.
• Designations not Shown.

— GIBBONEY —
CC• 20 Split Ends.
EE† 4, 5 & 6 Mill Scale Spots.
MM† 4 & 8 " " "
ZZ 1 & 202 " " "
OO 9 & 12 Scabs.

No[...]

—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT ANNAPOLIS, MARYLAND, OCTOBER 10, 1917.

AMERICAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

ANNAPOLIS, MARYLAND

EXPOSED OCTOBER 17 1916

Inspectors: 1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton.

Condition of Rust (continued from preceding block; left edge cut off)

Color 3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
M	M	M	L	M	M	M	T	TL	T	•	T	T	T	L	T
M	M	M	L	M	M	M	T	TL	T		T	T	T	L	T
M	M	M	L	M	M	M	T	TL	T		T	T	T	L	T
M	M	M	L	M	M	M	T	TL	TL	•	L	L	T	L	T
M	M	M	L	M	M	M	T	TL	TL		L	L	T	L	T
M	M	M	L	M	M	M	T	TL	TL		L	L	T	L	T
M	D	M	M	M	M	D	T	TL	T	•	T	T	T	L	T
M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	M	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T	•	T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
M	D	D	M	M	M	D	T	TL	T		T	T	T	L	T
D	D	D	D	D	D	D	T	TL	T	•	T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
D	D	D	D	D	D	D	T	TL	T		T	T	T	T	T
M	M	D	M	D	M	D	T	TL	T	•	L	T	T	L	T
M	M	D	M	D	M	D	T	TL	T		L	T	T	L	T
M	M	D	M	D	M	D	T	TL	T		L	T	T	L	T
M	M	D	M	D	M	D	T	TL	T		L	T	T	L	T
M	M	D	M	D	M	D	T	T	T		L	T	T	L	T
D	D	D	D	D	D	D	T	T	T	•	T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
D	D	D	D	D	D	D	T	T	T		T	T	T	T	T
M	M	D	M	D	M	D	T	T	T	•	T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
M	M	D	M	D	M	D	T	T	T		T	T	T	L	T
D	D	D	M	D	D	D	T	T	T	•	T	T	T	T	T
D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
D	D	D	M	D	D	D	T	T	T		T	T	T	T	T
D	D	D	M	D	D	D	T	T	T		T	T	T	T	T

ROW No. 6

Designation	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
KK*	61	S	S	S	M	C	VS	M	S	S	D	D	D	MD	D	D	D	D	D	T	T	T	•	T	T	T	T	T
	62	S	S	S	M	C	VS	M	S	S	D	D	D	MD	D	D	D	D	D	T	T	T		T	T	T	T	T
MM†	4	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T	•	L	T	T	T	T
	5	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	6	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	7	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	8	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	9	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	10	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	11	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	12	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	13	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
	14	M	M	M	M	C	M	C	M	C	M	M	M	M	M	M	M	M	D	T	TL	T		L	T	T	T	T
NN	4	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T	•	L	L	T	L	TL
	5	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	6	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	7	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	8	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	9	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	10	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	11	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	12	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	13	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
	14	M	C	M	C	M	C	C	C	C	M	L	M	L	D	L	L	L	L	T	L	T		L	L	T	L	TL
TT	4	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	L	T	•	T	T	T	L	T
	5	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	6	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	7	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	8	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	9	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	10	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	11	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	12	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	13	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
	14	M	S	M	M	M	S	M	M	M	D	M	D	D	D	M	D	M	D	T	TL	T		T	T	T	L	T
UU	4	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T	•	L	T	T	L	T
	5	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	6	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	7	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	8	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	9	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	10	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	11	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	12	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	13	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
	14	M	S	M	M	M	M	C	M	C	D	M	M	M	M	L	M	M	M	T	TL	T		L	T	T	L	T
VV	4	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T	•	L	L	T	L	T
	5	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T		L	L	T	L	T
	6	M	S	M	C	C	C	C	S	C	M	M	M	M	M	L	M	M	T	T	TL	T		L	L	T	L	T

ROW No. 5

Designation	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
VV	7	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T	•	L	T	T	L	T
	8	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	9	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	10	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	11	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	12	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	13	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
	14	M	S	M	M	C	C	M	M	M	M	M	M	L	M	M	M	M	M	T	TL	T		L	T	T	L	T
XX	4	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T	•	L	L	T	L	T
	5	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	6	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	7	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	8	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	9	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	10	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	11	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	12	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	13	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
	14	M	M	C	M	C	C	C	C	C	M	M	M	L	M	L	M	M	M	T	TL	T		L	L	T	L	T
ZZ	1	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T	•	L	L	T	L	T
	2	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T		L	L	T	L	T
	4	M	C	C	C	C	C	C	M	C	M	M	M	L	M	D	M	M	D	T	L	T		L	L	T	L	T
	205	S	S	M	M	M	M	M	M	M	D	D	M	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	201	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	302	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	303	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	[illegible]	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	202	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	D	M	D	T	TL	T		T	T	T	L	T
	204	S	S	S	M	M	M	M	S	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	206	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	402	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		L	T	T	L	T
	605	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		L	T	T	L	T
	710	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	711	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	102	S	S	S	M	M	M	M	M	M	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	101	S	S	S	M	M	M	M	M	M	D	D	D	D	M	D	M	M	D	T	TL	T		T	T	T	L	T
	417	S	M	M	M	C	M	M	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
	418	S	M	M	M	C	M	C	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
	419	S	M	M	M	C	M	C	M	M	D	M	M	D	M	D	L	M	D	T	L	T		L	T	T	L	T
OO	4	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT	•	L	L	T	L	T
	5	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	6	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	7	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	8	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	9	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	10	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	11	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T
	12	M	C	C	C	C	C	C	M	C	D	D	M	M	M	M	L	M	M	T	TL	LT		L	L	T	L	T

ROW No.

Designation	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
GG*	28	M	M	M	M	C	M	C	M	C	M	M	M	M	L	L	L	L	L	T	TL	T	•	L	T	T	L	TL
	29	M	M	M	M	C	M	C	M	C	M	M	M	M	L	L	L	L	L	T	TL	T		L	T	T	L	TL
	30	M	M	M	M	C	M	C	M	C	M	M	D	M	M	L	M	L	M	T	TL	T		L	T	T	L	TL
	31	M	M	M	M	C	M	C	M	C	M	M	M	M	M	L	L	M	L	T	TL	T		L	T	T	L	TL
	32	M	M	M	M	C	M	C	M	C	M	M	M	M	M	L	L	M	L	T	TL	T		L	T	T	L	TL
	33	M	M	M	M	C	M	C	M	C	M	M	M	M	M	L	L	M	L	T	TL	T		L	T	T	L	TL
	34	M	M	M	M	C	M	C	M	C	M	M	M	M	M	L	L	M	M	T	TL	T		L	T	T	L	TL
	35	M	M	M	M	C	M	C	M	C	M	M	M	M	M	L	L	M	M	T	TL	T		L	T	T	L	TL
A	4	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	5	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	6	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	7	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	8	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	9	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	10	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	11	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	12	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	13	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	14	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
	15	M	C	C	M	C	C	C	C	C	M	M	M	M	M	L	M	M	M	T	L	TL		L	L	T	L	T
B*	4	M	M	M	M	C	M	M	M	M	M	D	M	M	M	D	D	M	M	T	TL	T	•	T	L	T	L	T
	6	M	M	M	M	C	M	M	M	M	M	D	M	M	M	D	D	M	M	T	TL	T		T	L	T	L	T
	7	M	M	M	M	C	M	M	M	M	M	D	M	M	M	D	D	M	M	T	TL	T		T	L	T	L	T
	8	M	M	M	M	C	M	M	M	M	M	D	M	M	M	D	D	M	M	T	TL	T		T	L	T	L	T
	24	M	M	M	M	M	M	M	M	M	M	D	M	M	D	D	D	M	M	T	TL	T		T	L	T	L	T
	25	M	M	M	M	M	M	M	M	M	M	D	M	M	D	D	D	M	M	T	TL	T		T	L	T	L	T
	26	M	M	M	M	M	M	M	M	M	M	D	M	M	D	D	D	M	M	T	TL	T		T	L	T	L	T
	27	M	M	M	M	M	M	M	M	M	M	D	M	M	D	D	D	M	M	T	TL	T		T	L	T	L	T
	28	M	M	M	M	M	M	M	M	M	M	D	M	M	D	D	D	M	M	T	TL	T		T	L	T	L	T
C	4	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T	•	T	L	T	L	L
	5	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	15	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	16	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	17	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	23	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	24	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	25	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
	26	M	M	C	C	C	M	M	M	C	M	M	M	M	M	L	M	L	L	T	TL	T		T	L	T	L	L
D	8	M	C	C	C	C	C	M	C	C	M	L	M	M	M	L	M	L	M	T	L	T	•	L	L	T	L	T
	9	M	C	C	C	C	C	M	C	C	M	L	M	M	M	L	M	L	M	T	L	T		L	L	T	L	T
	12	M	C	C	C	C	C	M	C	C	M	L	M	M	M	L	M	L	M	T	L	T		L	L	T	L	T
	14	M	C	C	C	C	C	M	C	C	M	L	M	M	M	L	M	L	M	T	L	T		L	L	T	L	T
E	4	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T	•	T	L	T	L	T
	5	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	6	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	7	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	8	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	9	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	10	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T
	11	M	M	C	VC	M	C	C	M	VC	M	M	M	M	M	M	M	M	M	T	TL	T		T	L	T	L	T

— COOPER —
Notes: — OO 12 — Three Scabs.

— FLEMING —
Notes: — T 1 to 3 inc.
Shrubbery had Shaded Lower 20% of Sheets which were badly Discolored.
U 1-3 inc. Lower Ends Discolored by Shrubbery but not as much as "T's"
X 1 to 3 inc. Badly Discolored by Shrubbery, like "T" & "U".
OO 12. — 3 Blisters.
* Designations not Shown.

— GIBBONEY —
CC* 20 Split Ends.
EE† 4, 5 & 6 Mill Scale Spots.
MM† 4 & 8 " " "
ZZ 1 & 202 " " "
OO 9 & 12 Scabs.

— McADAM —
Notes: — None.

— McDONNELL —
Notes. — None.

Weather: *Cold and Cloudy.*

ROW No. 8

Designation	Panel No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
H	4	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T	•	T	T	T	L	T
	5	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	6	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	7	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	8	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	9	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	10	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	11	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	12	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	13	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	14	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	16	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
	18	M	S	SM	M	M	M	M	M	M	M	D	D	D	D	M	M	M	D	T	T	T		T	T	T	L	T
I	4	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T	•	T	T	T	L	T
	5	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	6	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	7	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	8	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	9	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	10	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	11	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	12	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	13	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	14	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	15	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
	16	M	S	SM	M	M	S	M	M	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	L	T
K	4	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T	•	T	T	T	T	T
	5	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	6	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	7	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	8	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	9	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	10	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	11	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	12	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	13	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	14	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	15	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
	16	M	S	S	M	M	S	M	S	M	M	D	D	D	D	M	D	M	D	T	T	T		T	T	T	T	T
M	4	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T	•	T	L	T	L	T
	5	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	6	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	7	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	8	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	9	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	10	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	11	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	12	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	13	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T
	14	M	M	S	M	M	M	C	M	M	M	M	D	M	D	L	M	M	D	T	T	T		T	L	T	L	T

ROW No. 9

Designation	Panel No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
S	4	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T	•	L	L	T	L	L
	5	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	6	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	7	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	8	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	9	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	10	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	11	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	12	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	13	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
	14	M	C	M	C	C	M	C	C	C	M	L	L	L	L	L	M	M	M	T	L	T		L	L	T	L	L
T	4	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T	•	T	L	T	L	T
	5	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	6	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	7	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	8	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	9	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	10	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	11	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	12	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	13	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
	14	M	S	S	M	M	M	M	S	S	M	D	D	D	D	D	D	D	D	T	T	T		T	L	T	L	T
U	4	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T	•	T	L	T	L	TL
	5	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	6	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	7	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	8	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	9	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	10	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	11	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	12	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	13	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
	14	M	M	M	C	M	M	M	M	C	M	L	M	L	D	M	M	M	M	T	TL	T		T	L	T	L	TL
V	4	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T	•	T	L	T	L	T
	5	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	6	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	7	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	8	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	9	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	10	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	11	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	12	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	13	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
	14	M	M	M	C	M	C	C	M	C	M	L	M	M	D	M	M	M	M	T	TL	T		T	L	T	L	T
Y*	1	M	M	S	C	S	M	M	VC	M	M	L	L	L	L	L	L	L	L	T	TL	T	•	L	T	T	L	T
	2	M	M	S	C	S	M	M	VC	M	M	L	L	L	L	L	L	L	L	T	TL	T		L	T	T	L	T
	3	M	M	S	C	S	M	M	VC	M	M	L	L	L	L	L	L	L	L	T	TL	T		L	T	T	L	T

ROW No. 10

Designation	Panel No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
X	4	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T	•	L	L	T	L	T
	5	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	6	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	7	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	8	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	9	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	10	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	11	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	12	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	13	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
	14	M	C	C	C	C	C	C	C	C	M	M	M	L	M	M	M	M	M	T	L	T		L	L	T	L	T
O	4	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L	•	L	L	L	L	L
	5	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	6	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	7	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	8	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	9	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	10	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	11	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
	12	C	C	C	C	C	VC	C	VC	VC	L	M	M	M	M	L	L	M	L	L	L	L		L	L	L	L	L
Z	101	S	S	VS	M	M	M	M	M	S	D	D	D	D	D	D	M	M	D	T	TL	T	•	T	T	T	L	T
	102	S	S	VS	M	M	M	M	M	S	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	104	S	S	VS	M	M	M	M	M	S	D	D	D	D	D	D	M	M	D	T	TL	T		T	T	T	L	T
	202	S	S	S	M	C	M	M	M	M	D	D	D	M	D	D	M	M	D	T	TL	T		T	T	T	L	T
	204	S	S	S	M	C	M	M	M	M	D	D	D	M	D	D	M	M	D	T	TL	T		T	T	T	L	T
	206	S	S	S	M	C	M	M	M	M	D	D	D	M	D	D	M	M	D	T	TL	T		T	T	T	L	T
	301	S	S	S	M	M	M	M	M	M	D	D	D	M	M	D	M	M	D	T	TL	T		T	T	T	L	T
	303	S	S	S	M	M	M	M	M	M	D	D	D	M	M	D	M	M	D	T	TL	T		T	T	T	L	T
	305	S	S	S	M	M	M	M	M	M	D	D	D	M	M	D	M	M	D	T	TL	T		T	T	T	L	T
	417	C	C	M	C	C	C	C	C	C	L	M	M	L	L	L	L	L	M	L	L	T		L	L	T	L	T
	418	C	C	M	C	C	C	C	C	C	L	M	M	L	L	L	L	L	M	L	L	T		L	L	T	L	T
	419	C	C	M	C	C	C	C	C	C	L	M	M	L	L	L	L	L	M	L	L	T		L	L	T	L	T
	501	S	S	S	M	M	M	M	M	M	D	D	D	D	M	D	M	D	D	T	TL	T		T	T	T	L	T
	502	S	S	S	M	M	M	M	M	M	D	D	D	D	M	D	M	D	D	T	TL	T		T	T	T	L	T
	504	S	S	S	M	M	M	M	M	M	D	D	D	D	M	D	M	D	D	T	TL	T		T	T	T	L	T
	602	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
	603	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
	604	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
	702	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
	705	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
	707	S	S	S	M	M	M	C	M	M	D	D	D	D	D	D	M	D	D	T	TL	T		T	T	T	L	T
OO*	12	M	M	C	C	C	C	C	C	C	M	M	M	D	L	L	M	M	M	T	L	TL	•	L	T	T	L	T
YY†	1	M	M	VS	C	S	C	C	S	M	M	L	L	L	L	L	L	L	L	T	TL	T	•	T	T	T	L	T
	2	M	M	VS	C	S	C	C	S	M	M	L	L	L	L	L	L	L	L	T	TL	T		T	T	T	L	T
	3	M	M	VS	C	S	C	C	S	M	M	L	L	L	L	L	L	L	L	T	TL	T		T	T	T	L	T

* Exposed 6-1-1[?]

* Exposed 11-28-10

† Exposed 6-1-12

— McDONNELL —
None.

— SMITH —
Notes : — None.

— WHEATON —
EE* 1, 2 & 3, — Traces of Scale Left.
OO 12, — Blisters.
Y* 1, 2 & 3, — Very Light.
YY† 1, 2, 3, — Very Light Traces of Scale.

Jas. H. Gibboney.
Chairman Inspection Committee

Date of Inspection *April 8, 1918*

ROW No. 1

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	11	C	VC	VC	C	VC		VC	VC	C	M	L	M	L	L		L	L	M	L	L	T		T		L	L	T
	12	C	VC	VC	C	VC		VC	VC	C	M	L	M	L	L		L	L	M	L	L	T		T		L	L	T
	13	C	VC	VC	C	VC		VC	VC	C	M	L	M	L	L		L	L	M	L	L	T		T		L	L	T
BB	4	M	S	C	M	M		M	M	M	M	M	D	M	D		M	M	M	T	T	T		T		T	T	T
	5	M	S	C	M	M		M	M	M	M	M	D	M	D		M	M	M	T	T	T		T		T	T	T
	6	M	S	C	M	M		M	M	M	M	M	D	M	D		M	M	M	T	T	T		T		T	T	T
CC	2	M	C	C	M	M		C	C	M	M	M	M	D	M		M	M	M	T	T	T		T		T	T	T
	5	M	C	C	M	M		C	C	M	M	M	M	D	M		M	M	M	T	T	T		T		T	T	T
	10	M	C	C	M	M		C	C	M	M	M	M	D	M		M	M	M	T	T	T		T		T	T	T
DD	18	M	C	C	M	C		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	19	M	C	C	M	C		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	20	M	C	C	M	C		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
EE⊕	7	M	M	M	M	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	8	M	M	M	M	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	9	M	M	M	M	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
HH	10	S	S	M	M	S		M	M	M	M	D	D	D	D		D	M	M	T	T	T		T		T	T	T
	11	S	S	M	M	S		M	M	M	M	D	D	D	D		D	M	M	T	T	T		T		T	T	T
	12	S	S	M	M	S		M	M	M	M	D	D	D	D		D	M	M	T	T	T		T		T	T	T
II	10	S	VS	S	S	VS		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	11	S	VS	S	S	VS		VS	S	SM	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	12	S	VS	S	S	VS		VS	S	SM	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
KK	4	S	S	M	S	S		S	M	M	M	M	D	D	D		M	M	M	T	T	T		T		T	T	T
	5	S	VS	M	S	S		S	M	M	M	M	D	D	D		M	M	M	T	T	T		T		T	T	T
	16	S	VS	M	S	S		S	M	M	M	D	D	D	D		D	M	M	T	T	T		T		T	T	T
MM⊕	15	S	M	M	C	M		M	VC	C	M	M	M	M	M		M	L	M	T	TL	T		T		T	T	T
	16	S	M	M	C	M		M	VC	C	M	M	M	M	M		M	L	M	T	TL	T		T		T	T	T
	17	S	M	M	C	M		M	VC	C	M	M	M	M	M		M	L	M	T	TL	T		T		T	T	T
SS	15	S	C	C	M	C		C	C	C	M	M	L	L	L		L	L	M	T	TL	T		T		L	T	T
	16	S	C	C	M	C		C	C	C	M	M	L	L	L		L	L	M	T	TL	T		T		L	T	T
	17	S	C	C	M	C		C	C	C	M	M	L	L	L		L	L	M	T	TL	T		T		L	T	T
TT	15	S	S	M	M	S		S	M	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	16	S	S	M	M	S		S	M	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	17	S	S	M	M	S		S	M	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
UU	15	S	VS	M	M	S		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	16	S	VS	M	M	S		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
	17	S	VS	M	M	S		M	M	M	M	D	M	M	M		D	M	M	T	T	T		T		T	T	T
VV	20	S	VS	M	C	S		S	M	M	M	D	M	L	D		D	M	M	T	T	T		T		T	T	T
	21	S	VS	M	C	S		S	M	M	M	D	M	L	D		D	M	M	T	T	T		T		T	T	T
	22	S	VS	M	C	S		S	M	M	M	D	M	L	D		D	M	M	T	T	T		T		T	T	T
XX	15	M	C	M	C	C		C	C	C	M	M	L	L	M		M	L	M	T	TL	T		L		L	T	T
	16	M	C	M	C	C		C	C	C	M	M	L	L	M		M	L	M	T	TL	T		L		L	T	T
	17	M	C	M	C	C		C	C	C	M	M	L	L	M		M	L	M	T	TL	T		L		L	T	T
OO	13	M	C	MC	C	C		M	VC	C	M	M	L	L	L		M	M	M	T	TL	T		L		L	L	T
	14	M	C	MC	C	C		M	VC	C	M	M	L	L	L		M	M	M	T	TL	T		L		L	L	T
	15	M	C	MC	C	C		M	VC	C	M	M	L	L	L		M	M	M	T	TL	T		L		L	L	T
CCC	11	M	M	C	M	M		M	C	M	M	D	D	D	D		M	M	M	T	T	T		T		T	L	T
	12	M	M	C	M	M		M	C	M	M	D	D	D	D		M	M	M	T	T	T		T		T	L	T
	13	M	M	C	M	M		M	C	M	M	D	D	D	D		M	M	M	T	T	T		T		T	L	T

⊕ Open Annealed.

ROW No. 2

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
A	16	C	VC	VC	M	C		C	VC	C	M	L	M	L	M		L	L	LM	L	L	T		L		L	L	T
	17	C	VC	VC	M	C		C	VC	C	M	L	M	L	M		L	L	LM	L	L	T		L		L	L	T
	18	C	VC	VC	M	C		C	VC	C	M	L	M	L	M		L	L	LM	L	L	T		L		L	L	T
B	9	S	S	C	M	S		M	C	M	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	10	S	S	C	M	S		M	C	M	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	11	S	S	C	M	S		M	C	M	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
C	6	S	M	C	M	M		M	M	M	M	M	M	D	M		L	L	L	T	T	T		T		T	T	T
	7	S	M	C	M	M		M	M	M	M	M	M	D	M		L	L	L	T	T	T		T		T	T	T
	8	S	M	C	M	M		M	M	M	M	M	M	D	M		L	L	L	T	T	T		T		T	T	T
D	16	S	M	C	C	M		M	C	C	M	M	M	L	L		L	L	L	T	T	T		T		T	T	T
	19	S	M	C	C	M		M	C	C	M	M	M	L	L		L	L	L	T	T	T		T		T	T	T
	22	S	M	C	C	M		M	C	C	M	M	M	L	L		L	L	L	T	T	T		T		T	T	T
E	13	S	M	M	M	S		C	C	M	M	M	D	M	M		M	L	L	T	T	T		T		T	T	T
	14	S	M	M	M	S		C	C	M	M	M	D	M	M		M	L	L	T	T	T		T		T	T	T
	15	S	M	M	M	S		C	C	M	M	M	D	M	M		M	L	L	T	T	T		T		T	T	T
H	19	S	S	M	M	S		S	S	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	20	S	S	M	M	S		S	S	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	21	S	S	M	M	S		S	S	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
I	19	S	VS	M	S	S		VS	S	S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	20	S	VS	M	S	S		VS	S	S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	21	S	VS	M	S	S		VS	S	S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
K	17	S	S	S	S	S		S	C	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	18	S	S	S	S	S		S	C	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
	19	S	S	S	S	S		S	C	M	M	D	M	D	M		D	M	M	T	T	T		T		T	T	T
M	15	S	M	M	M	M		M	C	C	M	M	M	M	M		M	L	L	T	T	T		T		T	T	T
	16	S	M	M	M	M		M	C	C	M	M	M	M	M		M	L	L	T	T	T		T		T	T	T
	17	S	M	M	M	M		M	C	C	M	M	M	M	M		M	L	L	T	T	T		T		T	T	T
S	15	M	C	C	C	C		C	C	VC	M	L	L	L	L		L	L	L	T	L	T		L		L	T	T
	16	M	C	C	C	C		C	C	VC	M	L	L	L	L		L	L	L	T	L	T		L		L	T	T
	17	M	C	C	C	C		C	C	VC	M	L	L	L	L		L	L	L	T	L	T		L		L	T	T
T	15	S	VS	M	M	S		S	M	M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	16	S	VS	M	M	S		S	M	M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	17	S	VS	M	M	S		S	M	M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
U	15	S	M	C	C	M		S	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	16	S	S	C	C	M		S	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
	17	S	S	C	C	M		S	S	M	M	D	M	M	M		M	M	M	T	T	T		T		T	T	T
V	15	S	S	M	C	M		S	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	16	S	S	M	C	M		S	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	17	S	S	M	C	M		S	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
X	15	M	C	C	C	C		M	C	C	M	M	M	L	M		L	M	M	T	L	T		T		L	L	T
	16	M	C	C	C	C		M	C	C	M	M	M	L	M		L	M	M	T	L	T		T		L	L	T
	17	M	C	C	C	C		M	C	C	M	M	M	L	M		L	M	M	T	L	T		T		L	L	T
O	13	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L		L		L	L	L
	14	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L		L		L	L	L
	15	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L		L		L	L	L
[illegible]	4	M	C	C	M	VC		VC	C	M	M	M	M	D	M		L	M	M	T	L	T		L		L	L	T
	5	M	C	C	M	VC		VC	C	M	M	M	M	D	M		L	M	M	T	L	T		L		L	L	T
	109	VS	VS	VS	S	VS		S	S	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T

ROW No. 3

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	14	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	15	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	16	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	17	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	18	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	19	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
	20	C	VC	VC	C	VC		VC	VC	VC	L	L	L	L	L		L	L	LM	L	L	L		L		L	L	L
AA*	42	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	43	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	44	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	45	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	46	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	47	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	48	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
	49	M	C	C	M	C		C	C	M	M	M	L	L	M		L	M	M	L	TL	TL		T		L	T	T
BB	14	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	15	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	16	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	17	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	18	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
	19	S	S	M	M	S		M	M	M	M	D	M	M	D		M	M	M	T	T	T		T		T	T	T
BB*	29	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	30	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	31	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	32	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	46	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	47	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	48	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
	49	VS	VS	S	S	S		S	S	S	M	D	D	M	D		M	M	M	T	T	T		T		T	T	T
CC	11	S	M	M	M	C		C	C	C	M	L	L	D	M		L	L	L	T	T	T		T		T	T	T
	12	S	M	M	M	C		C	C	C	M	L	L	D	M		L	L	L	T	T	T		T		T	T	T
	13	S	M	M	M	C		C	C	C	M	L	L	D	M		L	L	L	T	T	T		T		T	T	T
	14	S	M	M	M	C		C	C	C	M	L	L	D	M		L	L	L	T	T	T		T		T	T	T
CC*	26	S	S	S	M	M		M	M	M	M	M	D	D	M		L	M	M	T	T	T		T		T	T	T
	27	S	S	S	M	M		M	M	M	M	M	D	D	M		L	M	M	T	T	T		T		T	T	T
	28	S	S	S	M	M		M	M	M	M	M	D	D	M		L	M	M	T	T	T		T		T	T	T
	29	S	S	S	M	M		M	M	M	M	M	D	D	M		L	M	M	T	T	T		T		T	T	T
	30	S	S	S	M	M		M	M	M	M	M	D	D	M		L	M	M	T	T	T		T		T	T	T
DD	5	S	M	C	M	M		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	6	S	M	C	M	M		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	7	S	M	C	M	M		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	21	S	M	C	M	C		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	22	S	M	C	M	C		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	23	S	M	C	M	C		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
	24	S	M	C	M	C		C	C	C	M	M	L	L	M		L	M	M	T	T	T		T		T	T	T
YY†	6	S	C	C	S	M		C	C	C	M	L	M	M	L		L	L	L	T	T	T		T		T	T	T
	4	S	C	C	S	M		C	C	C	M	L	M	M	L		L	L	L	T	T	T		T		T	T	T
	5	S	C	C	S	M		C	C	C	M	L	M	M	L		L	L	L	T	T	T		T		T	T	T
Y†	4	S	M	M	S	S		C	M	M	M	M	D	M	M		M	M	M	T	T	T		T		T	T	T

* Sand Blasted

† Exposed 6-13-17

ROW No. 4

Mark	Sheet No.	1 Aupperle	2 Buck	3 Cooper
DD*	39	VS	S	S
	40	VS	S	S
	44	VS	S	S
	45	VS	S	S
	46	VS	S	S
	50	VS	S	S
	51	VS	S	S
	52	VS	S	S
	53	VS	S	S
EE†	10	S	M	S
	11	S	M	S
	12	S	M	S
EE*	25	VS	S	VS
	26	VS	S	VS
	27	VS	S	VS
	28	VS	S	VS
	29	VS	S	VS
	30	VS	S	VS
HH	13	S	S	S
	14	S	S	S
	15	S	S	S
	16	S	S	S
	17	S	S	S
	18	S	S	S
HH*	35	VS	VS	S
	36	VS	VS	S
	37	VS	VS	S
	38	VS	VS	S
	39	VS	VS	S
	40	VS	VS	S
	41	VS	VS	S
	42	VS	VS	S
II	13	VS	S	M
	14	VS	S	M
	15	VS	S	M
	16	VS	S	M
	17	VS	S	M
	18	VS	S	M
	19	VS	S	M
II*	39	VS	VS	S
	40	VS	VS	S
	41	VS	VS	S
	42	VS	VS	S
	43	VS	VS	S
	44	VS	VS	S
	45	VS	VS	S
	46	VS	VS	S
	47	VS	VS	S

* Sand Blasted

† Open Annealed

CONDITION OF RUST.

Texture	Color	Adherence
VS—Very Smooth	L—Light	T—Tight
S—Smooth	M—Medium	L—Loose
M—Medium	D—Dark	
C—Coarse		
VC—Very Coarse		

— INSPECTION COMMITTEE —

J. H. Gibboney, – Chairman, – Norfolk & Western Ry. Co.
J. A. Aupperle, – American Rolling Mill Co.
D. M. Buck, – American Sheet & Tin Plate Co.
W. A. Cooper, – Alan Wood Iron & Steel Co.
W. R. Fleming, – The Andrews Steel Co.
D. J. McAdam, Jr. – U. S. Navy, Bureau Steam Engineering.
M. E. McDonnell, – Pennsylvania Railroad Co.
H. E. Smith, – New York Central Railroad Co.
F. B. Wheaton, – U. S. Army, Quartermaster's Corps.

— AUPPERLE —

Notes: – None.

— BUCK —

Notes: – None.

TABLE IV.—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT FORT SHERIDAN

AMERICAN SOCIETY FOR TESTING MATERIALS
COMMITTEE A-5 ON CORROSION OF IRON AND STEEL
TESTS OF UNCOATED SHEETS
FORT SHERIDAN, ILL.
EXPOSED APRIL 9, 1917

ROW No. 4

Designation: Brand	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
DD*	39	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	40	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	44	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	45	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	46	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	50	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	51	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	52	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
	53	VS	S	S	M	S		M	M	M	M	D	M	L	D		M	M	M	T	T	T		T		T	T	T
EE†	10	S	M	S	C	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	11	S	M	S	C	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
	12	S	M	S	C	M		M	C	M	M	M	M	M	M		M	M	M	T	T	T		T		T	T	T
FF*	25	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	26	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	27	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	28	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	29	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
	30	VS	S	VS	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T		T		T	T	T
HH	13	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	14	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	15	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	16	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	17	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	18	S	S	S	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
HH*	35	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	36	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	37	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	38	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	39	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	40	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	41	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	42	VS	VS	S	S	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
II	13	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	14	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	15	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	16	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	17	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	18	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
	19	VS	S	M	S	M		S	M	M	M	D	L	D	M		D	M	M	T	T	T		T		T	T	T
JJ*	39	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	40	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	41	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	42	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	43	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	44	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	45	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	46	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	47	VS	VS	S	S	S		VS	S	S	D	D	M	D	D		D	M	M	T	T	T		T		T	T	T

* Sand Blasted.
† Open Annealed.

ROW No. 5

Designation: Brand	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
KK	19	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	20	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	21	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	22	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	23	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	24	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	26	S	S	M	S	M		S	M	M	M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
KK*	43	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	44	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	L	M	T	T	T		T		T	T	T
	45	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	L	M	T	T	T		T		T	T	T
	46	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	47	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	48	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	49	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
	50	VS	VS	S	VS	S		VS	VS	S	D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
MM†	18	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	19	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	20	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	21	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	22	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	23	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	24	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	25	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	26	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	27	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
	28	M	C	C	C	C		M	C	C	M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
SS	18	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	19	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	20	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	22	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	23	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	24	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	25	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	26	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
	27	M	C	C	M	C		C	C	C	M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
TT	18	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	19	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	20	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	21	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	22	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	23	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	24	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	26	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	27	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
	28	S	S	M	M	M		M	M	C	D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
U‡	6	M	C	C	C	C		C	C	C	L	L	L	L	L		M	L	L	T	L	T		L		T		T
	5	M	S	C	C	M		C	S	C	L	D	L	D	M		M	M	L	T	T	T		T		T		T

* Sand Blasted.
† Open Annealed.
‡ [illegible]

ROW No. 6

Designation: Brand	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
UU	18	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	19	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	21	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	23	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
VV	23	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	29	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	30	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	31	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	32	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	33	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	34	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	35	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	36	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	37	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	38	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M		T	T	T		T		T	T	T
XX	18	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	19	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	20	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	21	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	22	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	23	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	24	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	25	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	26	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	27	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	28	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
ZZ	5	S	C	M	M	C		C	C	M	M	L	L	M	L		L	L	M	T	TL	T		L		T	L	T
	7	S	C	M	M	C		C	C	M	M	L	L	M	L		L	L	M	T	TL	T		L		T	L	T
	300	VS	VS	S	S	S		S	S	S	D	D	M	D	D		D	D	D	T	T	T		T		T	T	T
	305	VS	VS	S	S	S		S	S	S	D	D	M	D	D		D	D	D	T	T	T		T		T	T	T
	505	VS	VS	VS	M	S		S	S	S	D	D	D	M	D		D	D	D	T	T	T		T		T	T	T
	506	VS	VS	VS	M	S		S	S	S	D	D	D	M	D		D	D	D	T	T	T		T		T	T	T
	610	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T
	611	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T

ROW No. 7

Designation: Brand	Sheet No.
ZZ	108
	205
	206
	420
	422
	712
	713
OO	[illegible]
	17
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
CCC	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
	[illegible]
A	19
	20
	21
	22
	23
	24
	25
	26
	27
	28
	29
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B	12
	13
	14
	15
	16
	29
	30
	31
	32
	33
E	710

— COOPER —

Notes:
K 22 1 Bullet Hole.
U 25 " "
U 26, 2 " Holes.

— FLEMING —

Notes:
U 25 & 26 Rifle Holes.
No Records made of Adherence.

— GIBBONEY —

Notes:
MM* 15 – Light Scale.
MM† 18 – Mill Scale.
K 21 – 1 Hole.
U 25 – 1 "
U 26 – 2 Holes.

— McADAM —

Notes:
Did not make this Inspection

…TION OF CORROSION TEST SHEETS, AT FORT SHERIDAN, ILL., APRIL 8, 1918.

AMERICAN SOCIETY FOR TESTING MATERIALS

COMMITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

FORT SHERIDAN, ILL.

EXPOSED APRIL 9, 1917

Weather *Cold and Cloudy*

Condition of Rust (continued from preceding row)

Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
M	M	L	D	M		D	M	M	T	T	T		T		T	T	T
D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
D	M	M	D	M		D	L	M	T	T	T		T		T	T	T
D	M	M	D	M		D	L	M	T	T	T		T		T	T	T
D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
D	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	M	L		M	M	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
M	L	L	L	M		L	L	L	T	TL	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
D	D	D	D	M		D	M	M	T	T	T		T		T	T	T
L	L	L	L	L		M	L	L	T	L	T		L		T		T
L	D	L	D	M		M	M	L	T	T	T		T		T		T

ROW No. 6

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
CC	18	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	19	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	20	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	22	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	23	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	S	M	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
VV	23	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	24	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	26	S	S	M	M	M		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	27	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	28	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	29	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	30	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	31	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	32	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	33	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	34	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	35	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	36	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	37	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M	M	T	T	T		T		T	T	T
	38	S	S	M	M	C		S	M	M	M	M	M	M	M		D	M		T	T	T		T		T	T	T
XX	19	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	19	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	20	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	21	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	22	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	23	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	24	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	25	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	26	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	27	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
	28	C	C	C	C	C		M	M	M	M	L	M	L	M		L	M	M	T	TL	T		T		T	T	T
ZZ	5	S	C	M	M	C		C	C	M	M	L	L	M	L		L	L	M	T	TL	T		L		T	L	T
	7	S	C	M	M	C		C	C	M	M	L	L	M	L		L	L	M	T	TL	T		L		T	L	T
	808	VS	VS	S	S	S		S	S	S	D	D	M	D	D		D	D	D	T	T	T		T		T	T	T
	809	VS	VS	S	S	S		S	S	S	D	D	M	D	D		D	D	D	T	T	T		T		T	T	T
	905	VS	VS	VS	M	S		S	S	S	D	D	D	M	D		D	D	D	T	T	T		T		T	T	T
	906	VS	VS	VS	M	S		S	S	S	D	D	D	M	D		D	D	D	T	T	T		T		T	T	T
	610	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T
	611	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T

ROW No. 7

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
ZZ	106	S	S	S	M	S		S	M	M	M	M	D	D	L		D	M	M	T	T	T		T		T	T	T
	205	S	S	S	S	S		S	M	M	M	M	D	D	L		D	M	M	T	T	T		T		T	T	T
	206	S	S	S	S	S		S	M	M	M	M	D	D	L		D	M	M	T	T	T		T		T	T	T
	420	S	C	M	C	M		M	C	C	M	L	M	L	M		M	M	L	T	TL	T		T		T	T	T
	422	S	C	M	C	M		M	C	C	M	L	M	L	M		M	M	L	T	TL	T		T		T	T	T
	712	S	S	VS	M	M		S	M	M	M	M	D	D	M		D	M	M	T	T	T		T		T	T	T
	713	S	S	VS	M	M		S	M	M	M	M	D	D	M		D	M	M	T	T	T		T		T	T	T
OO	16	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	17	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	18	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	19	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	20	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	21	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	22	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	23	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
	24	M	VC	C	C	C		M	M	C	M	L	L	L	L		L	M	M	T	TL	T		T		L	T	T
CCC	16	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	17	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	18	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	19	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	20	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	21	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	22	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	23	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
	24	M	M	C	M	C		C	C	C	M	M	L	D	M		M	M	M	T	TL	T		T		T	T	T
A	19	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	20	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	21	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	22	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	23	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	24	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	25	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	26	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	27	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	28	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	29	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
	30	C	VC	VC	C	VC		VC	C	C	M	M	L	L	M		L	L	M	L	L	L		L		L	L	L
B	12	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	13	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	14	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	15	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	16	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	29	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	30	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	31	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	32	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
	33	M	S	M	M	S		M	S	M	M	D	M	M	D		M	M	D	T	T	T		T		T	T	T
Z	710	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T		T		T	T	T

ROW No. 8

Mark	Sheet No.	Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney
C	9	S	M	M	M	M		S	M	M	M	M	L	D	M
	10	S	M	M	M	M		M	M	M	M	M	L	D	M
	18	S	M	M	M	M		S	M	M	M	M	L	D	M
	19	S	M	M	M	M		M	M	M	M	M	L	D	M
	27	S	M	M	M	M		S	M	M	M	M	L	D	M
	28	S	M	M	M	M		S	M	M	M	M	L	D	M
	29	S	M	M	M	M		M	M	M	M	M	L	D	M
	30	S	M	M	M	M		S	M	M	M	M	L	D	M
	31	S	M	M	M	M		M	M	M	M	M	L	D	M
D	26	S	M	M	M	M		M	M	M	M	L	L	L	M
	28	S	M	M	M	M		M	M	M	M	L	L	L	M
	29	S	M	M	M	M		M	M	M	M	L	L	L	M
E	16	S	S	S	M	M		M	M	M	M	M	M	D	M
	17	S	S	S	M	M		S	M	M	M	M	M	D	M
	18	S	S	S	M	M		S	M	M	M	M	M	D	M
	19	S	S	S	M	M		M	M	M	M	M	M	D	M
	20	S	S	S	M	M		S	M	M	M	M	M	D	M
	21	S	S	S	M	M		S	M	M	M	M	M	D	M
	22	S	S	S	M	M		S	M	M	M	M	M	D	M
	23	S	S	S	M	M		M	M	M	M	M	M	D	M
	24	S	S	S	M	M		M	M	M	M	M	M	D	M
H	23	S	S	M	S	S		S	S	M	M	M	M	D	M
	24	S	S	M	S	S		S	S	M	M	M	M	D	M
	25	S	S	M	S	S		S	S	M	M	M	M	D	M
	26	S	S	M	S	M		S	M	M	M	M	M	D	M
	29	S	S	M	S	S		S	S	M	M	M	M	D	M
	33	S	S	M	S	M		S	M	M	M	M	M	D	M
	35	S	S	M	S	M		S	M	M	M	M	M	D	M
	36	S	S	M	S	M		S	M	M	M	M	M	D	M
I	22	S	VS	S	S	S		VS	S	S	M	D	M	D	D
	23	S	VS	S	S	S		VS	S	S	M	D	M	D	D
	24	S	VS	S	S	S		VS	M	S	M	D	M	D	D
	25	S	VS	S	S	S		S	M	S	M	D	M	D	D
	26	S	VS	S	S	S		S	M	S	M	D	M	D	D
	27	S	VS	S	S	S		S	S	S	M	D	M	D	D
	28	S	VS	S	S	S		S	M	S	M	D	M	D	D
	29	S	VS	S	S	S		VS	S	S	M	D	M	D	D
	30	S	VS	S	S	S		VS	M	S	M	D	M	D	D
	31	S	VS	S	S	S		VS	M	S	M	D	M	D	D
	32	S	VS	S	S	S		VS	S	S	M	D	M	D	D
	33	S	VS	S	S	S		S	M	S	M	D	M	D	D
	34	S	VS	S	S	S		S	M	S	M	D	M	D	D
	35	S	VS	S	S	S		VS	M	S	M	D	M	D	D
	36	S	VS	S	S	S		S	M	S	M	D	M	D	D
	37	S	VS	S	S	S		S	M	S	M	D	M	D	D
Z	805	VS	VS	S	S	S		M	S	S	D	D	D	D	D
	906	VS	VS	S	S	S		M	S	S	D	D	D	D	D
	710	VS	VS	S	S	S		M	S	S	D	D	D	D	D

…erence.

— GIBBONEY —

Notes:
MM* 15 – Light Scale.
MM† 18 – Mill Scale.
K 21 – 1 Hole.
U 25 – 1 "
U 26 – 2 Holes.

— McADAM —

Notes:
Did not make this Inspection.

— McDONNELL —

Notes:
XX 15, 16 & 17 Color Medium to Light.
OO 13, 14 & 15 " " " "
CC 11 to 14 inc. Adherence Approaching Loose.
DD* 39 " 53 " Texture " Smooth
and Color Light
SS 18 to 27 inc. Adherence Approaching Loose Rating.
XX 18 " 28 " " " " "
ZZ 420 & 422 Color " Light.
OO 16 to 24 inc. Adherence Moderately Loose.
A 19 " 30 " " " "
S 18 " 28 " " Approaching "

X 18…
O 16…
C 42…

...Cloudy

Texture 9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	M	L	D	M		M	M	L	T	T	T		T		T	T	T
M	M	L	L	L	M		M	M	L	T	T	T		T		T	T	T
M	M	L	L	L	M		M	M	L	T	T	T		T		T	T	T
M	M	L	L	L	M		M	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	L	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
M	M	M	M	D	M		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
S	D	D	D	D	D		D	M	D	T	T	T		T		T	T	T
S	D	D	D	D	D		D	M	D	T	T	T		T		T	T	T
S	D	D	D	D	D		D	M	D	T	T	T		T		T	T	T

ROW No. 9

DESIGNATION Mark	Sheet No.	CONDITION OF RUST Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
K	20	S	S	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	21	S	S	M	M	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	22	S	S	M	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	23	S	S	M	M	S		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	24	S	S	M	M	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	25	S	S	M	M	S		S	M	C	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	26	S	S	M	M	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	27	S	S	M	M	M		S	M	C	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	28	S	S	M	M	M		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	29	S	S	M	M	M		S	M	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	30	S	S	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	31	S	S	M	M	S		VS	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	32	S	S	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
R	18	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	19	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	20	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	21	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	22	S	M	M	M	S		M	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	23	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	24	S	M	M	M	S		M	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	25	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	26	S	M	M	M	S		S	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	27	S	M	M	M	S		M	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
	28	S	M	M	M	S		M	M	M	M	D	M	D	M		M	M	M	T	T	T		T		T	T	T
S	18	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	19	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	20	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	21	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	22	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	23	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	24	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	25	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	26	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	27	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
	28	C	C	VC	C	C		M	C	C	M	L	L	L	L		L	L	L	T	TL	T		T		T	T	T
T	18	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	19	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	20	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	21	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	22	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	23	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	24	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	25	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	26	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	27	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
	28	M	VS	M	M	S		S	S	M	M	D	M	D	D		D	M	M	T	T	T		T		T	T	T
U	18	M	S	C	M	M		M	M	M	M	D	M	M	D		D	M	M	T	T	T		T		T	T	T
	19	M	S	C	M	M		S	M	M	M	D	M	M	D		D	M	M	T	T	T		T		T	T	T
	20	M	S	C	M	M		S	M	M	M	D	M	M	D		D	M	M	T	T	T		T		T	T	T
	21	M	S	C	M	M		S	M	M	M	D	M	M	D		D	M	M	T	T	T		T		T	T	T

ROW No. 10

DESIGNATION Mark	Sheet No.	CONDITION OF RUST Texture 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
U	22	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	23	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	24	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	25	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	26	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	27	C	M	C	C	M		S	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
	28	C	M	C	C	M		M	M	C	L	M	L	L	M		D	M	M	T	T	T		T		T	T	T
V	18	M	S	M	C	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	19	M	S	M	C	S		VS	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	20	M	S	M	C	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	21	M	S	M	C	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	22	M	S	M	S	S		S	M	M	L	M	L	D	M		D	M	M	T	T	T		T		T	T	T
	23	M	S	M	M	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	24	M	S	M	M	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	25	M	S	M	M	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	26	M	S	M	M	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	27	M	S	M	M	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
	28	M	S	M	C	S		S	M	M	L	M	L	M	M		D	M	M	T	T	T		T		T	T	T
X	18	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	19	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	20	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	21	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	22	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	23	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	24	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	25	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	26	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	27	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
	28	C	C	M	M	C		C	C	C	L	L	M	M	M		L	L	L	L	TL	T		T		L	T	T
O	16	VC	VC	M	M	VC		C	VC	C	L	L	L	L	L		L	L	L	L	L	L		L		L	L	L
	17	VC	VC	M	M	VC		C	VC	C	L	L	L	D	L		L	L	L	L	L	L		L		L	L	L
	18	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	19	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	20	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	21	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	22	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	23	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
	24	VC	VC	M	M	VC		C	VC	C	L	L	L	M	L		L	L	L	L	L	L		L		L	L	L
Z	110	VS	VS	VS	M	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T		T		T	T	T
	207	VS	VS	VS	M	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T		T		T	T	T
	208	VS	VS	VS	M	S		S	S	S	M	D	D	D	M		D	M	D	T	T			T		T	T	T
	306	VS	VS	VS	M	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T		T		T	T	T
	308	VS	VS	VS	M	S		S	S	S	M	D	D	D	M		D	M	D	L	T	T		T		T	T	T
	420	S	C	S	C	C		C	C	M	L	L	D	M	L		L	L	M	L	L	T		L		L	T	T
	421	S	C	S	C	C		C	C	M	L	L	D	M	L		L	L	M	L	L	T		L		L	T	T
	506	VS	VS	VS	M	S		S	S	S	M	D	D	D	D		D	M	D	T	T	T		T		T	T	T
	508	VS	VS	VS	M	S		S	S	S	M	D	D	D	D		D	M	D	T	T	T		T		T	T	T

X 18 to 28 inc. Adherence Moderately Loose.
O 16 " 24 " " " "
C 420 & 421 " " "

...h

...e Rating.

"

...ht.

...se.

— SMITH —

Notes:
EE* 8 & 9 Traces Mill Scale Left.
MM* 15 to 17 inc. " " " "
EE† 10 " " " "
U 25 & 26 - Bullet Holes.
Y† 6 & 5 Adherence Record inadvertently Omitted.

— WHEATON —

Notes: EE* 7 to 9 inc. Scale Trace.
MM* 15 " 17 " " "
XX 15 " 17 " " "
VV† 5 & 6 " "
EE† 10 to 12 " " "
MM† 19 & 20 Scale.
MM† 21 to 28 " " Trace.
XX 22 " 24 " " "
OO 22 & 23 " "

Jas. H. Gibboney.

Corrosion Inspection Committee

Date of Inspection April 9.. 1918

ROW No. 1

Mark	Sheet No.	Texture									Color									Adherence								
		1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	21	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	22	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	23	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	24	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
BB	8	M	S	S	S	M		M	M	S	M	D	M	D	D		D	D	D	T	T	T	T	T		T	T	T
	9	M	S	S	S	M		M	M	S	M	D	M	D	D		D	D	D	T	T	T	T	T		T	T	T
	20	C	C	M	M	C		C	C	C	L	L	L	M	M		M	L	L	L	L	TL	T	L		L	L	L
	21	C	C	M	M	C		C	C	C	L	L	L	M	M		M	L	L	L	L	TL	T	L		L	L	L
CC	15	M	M	M	S	M		M	C	M	M	D	M	D	M		M	M	M	T	TL	T	T	T		L	T	T
	16	M	M	M	S	M		M	C	M	M	D	M	D	M		M	M	M	T	TL	T	T	T		L	T	T
	17	M	M	M	S	M		M	C	M	M	D	M	D	M		M	M	M	T	TL	T	T	T		L	T	T
	18	M	M	M	S	M		M	C	M	M	D	M	D	M		M	M	M	T	TL	T	T	T		L	T	T
DD	25	C	C	C	M	C		C	VC	C	L	M	L	M	M		M	M	L	L	L	TL	L	L		L	L	T
	26	C	C	C	M	C		C	VC	C	L	M	L	M	M		M	M	L	L	L	TL	L	L		L	L	T
	27	C	C	C	M	C		C	VC	C	L	M	L	M	M		M	M	L	L	L	TL	L	L		L	L	T
	28	C	C	C	M	C		C	VC	C	L	M	L	M	M		M	M	L	L	L	TL	L	L		L	L	T
EE*	13	M	S	S	S	S		M	M	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	14	M	S	S	S	S		M	M	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	15	M	S	S	S	S		M	M	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	16	M	S	S	S	S		M	M	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
HH	19	M	S	S	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	20	M	S	S	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	21	M	S	S	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	22	M	S	S	S	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
II	20	S	VS	S	VS	S		VS	S	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	21	S	VS	S	VS	S		VS	S	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	22	S	VS	S	VS	S		VS	S	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	23	S	VS	S	VS	S		VS	S	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
KK	6	S	VS	VS	VS	S		S	S	VS	D	D	D	D	D		M	D	D	T	T	T	T	T		T	T	T
	7	S	VS	VS	VS	S		S	S	VS	D	D	D	D	D		M	D	D	T	T	T	T	T		T	T	T
	8	S	VS	VS	VS	S		S	S	VS	D	D	D	D	D		M	D	D	T	T	T	T	T		T	T	T
	27	S	VS	VS	VS	S		S	S	VS	D	D	D	D	D		M	D	D	T	T	T	T	T		T	T	T
MM*	29	M	M	C	M	M		M	C	C	M	M	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	30	M	M	C	M	M		M	C	C	M	M	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	31	M	M	C	M	M		M	C	C	M	M	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	32	M	M	C	M	M		M	C	C	M	M	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
NN	29	M	VC	VC	C	C		VC	C	VC	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	30	M	VC	VC	C	C		VC	C	VC	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	31	M	VC	VC	C	C		VC	C	VC	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	32	M	VC	VC	C	C		VC	C	VC	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
TT	29	S	S	S	VS	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	30	S	S	S	VS	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	31	S	S	S	VS	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	32	S	S	S	VS	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
UU	29	S	S	M	S	S		S	S	S	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	30	S	S	M	S	S		S	S	S	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	31	S	S	M	S	S		S	S	S	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	32	S	S	M	S	S		S	S	S	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
VV	39	S	S	M	S	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	40	S	S	M	S	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	41	S	S	M	S	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	42	S	S	M	S	S		S	S	S	M	D	D	D	M		D	M	D	T	T	T	T	T		T	T	T
XX	29	C	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	30	C	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	31	C	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	32	C	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
OO	25	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	26	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	27	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	28	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
CCC	1	VS	S	M	S	S		S	M	M	D	D	D	D	M		D	D	D	T	T	T	T	T		T	T	T
	2	VS	S	M	S	S		S	M	M	D	D	D	D	M		D	D	D	T	T	T	T	T		T	T	T
	3	VS	S	M	S	S		S	M	M	D	D	D	D	M		D	D	D	T	T	T	T	T		T	T	T
	4	VS	S	M	S	S		S	M	M	D	D	D	D	M		D	D	D	T	T	T	T	T		T	T	T
ZZ	8	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	10	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	11	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	105	M	S	S	M	S		M	S	S	M	M	M	M	M		M	M	D	L	T	T	T	T		T	T	T
	310	VS	VS	VS	VS	VS		S	VS	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	311	VS	VS	VS	VS	VS		S	VS	VS	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T

ROW No. 2

Mark	Sheet No.	Texture									Color									Adherence								
		1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
A	31	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	32	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	33	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	34	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	M	M	L	L	L	L	L		L	L	L
B	17	M	S	C	M	M		M	M	M	M	M	D	M	M		M	D	D	T	TL	TL	L	T		L	T	T
	18	M	S	C	M	M		M	M	M	M	M	D	M	M		M	D	D	T	TL	TL	L	T		L	T	T
	19	M	S	C	M	M		M	M	M	M	M	D	M	M		M	D	D	T	TL	TL	L	T		L	T	T
	20	M	S	C	M	M		M	M	M	M	M	D	M	M		M	D	D	T	TL	TL	L	T		L	T	T
C	11	C	M	C	C	M		M	M	M	M	M	D	M	D		M	M	D	T	TL	TL	L	T		L	T	T
	12	C	M	C	C	M		M	M	M	M	M	D	M	D		M	M	D	T	TL	TL	L	T		L	T	T
	13	C	M	C	C	M		M	M	M	M	M	D	M	D		M	M	D	T	TL	TL	L	T		L	T	T
	14	C	M	C	C	M		M	M	M	M	M	D	M	D		M	M	D	T	TL	TL	L	T		L	T	T
D	30	C	C	VC	C	VC		VC	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	31	C	C	VC	C	VC		VC	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	33	C	C	VC	C	VC		VC	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	34	C	C	VC	C	VC		VC	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
E	25	M	M	C	C	M		M	M	M	M	D	M	D	D		D	M	D	T	TL	T	T	T		L	L	T
	26	M	M	C	C	M		M	M	M	M	D	M	D	D		D	M	D	T	TL	T	T	T		L	L	T
	27	M	M	C	C	M		M	M	M	M	D	M	D	D		D	M	D	T	TL	T	T	T		L	L	T
	28	M	M	C	C	M		M	M	M	M	D	M	D	D		D	M	D	T	TL	T	T	T		L	L	T
H	39	M	S	C	M	M		M	S	M	M	D	M	D	D		M	M	D	T	T	T	T	T		L	T	T
	40	M	S	C	M	M		S	S	M	M	D	M	D	D		D	M	D	T	T	T	T	T		T	T	T
	41	M	S	C	M	M		S	S	M	M	D	M	D	D		D	M	D	T	T	T	T	T		T	T	T
	42	M	S	C	M	M		S	S	M	M	D	M	D	D		D	M	D	T	T	T	T	T		T	T	T
I	38	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	39	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	40	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	41	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
K	33	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	34	S	VS	M	S	S		S	S	M	D	D	D	D	D		C	M	D	T	T	T	T	T		T	T	T
	35	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	36	S	VS	M	S	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
M	29	C	M	M	M	M		M	M	C	M	D	M	M	M		M	M	D	T	TL	T	T	T		L	L	T
	30	C	M	M	M	M		M	M	C	M	D	M	M	M		M	M	D	T	TL	T	T	T		L	L	T
	31	C	M	M	M	M		M	M	C	M	D	M	M	M		M	M	D	T	TL	T	T	T		L	L	T
	32	C	M	M	M	M		M	M	C	M	D	M	M	M		M	M	D	T	TL	T	T	T		L	L	T
N	29	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	30	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	31	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	32	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
T	29	M	S	M	M	M		M	M	M	M	D	M	D	M		D	M	M	T	TL	T	T	T		T	L	T
	30	M	S	M	M	M		M	M	M	M	D	M	D	M		D	M	M	T	TL	T	T	T		T	L	T
	31	M	S	M	M	M		M	M	M	M	D	M	D	M		D	M	M	T	TL	T	T	T		T	L	T
	32	M	S	M	M	M		M	M	M	M	D	M	D	M		D	M	M	T	TL	T	T	T		T	L	T
U	29	M	S	C	C	M		M	M	M	M	D	M	M	M		D	M	M	T	TL	TL	L	T		T	L	T
	30	M	S	C	C	M		M	M	M	M	D	M	M	M		D	M	M	T	TL	TL	L	T		T	L	T
	31	M	S	C	C	M		M	M	M	M	D	M	M	M		D	M	M	T	TL	TL	L	T		T	L	T
	32	M	S	C	C	M		M	M	M	M	D	M	M	M		D	M	M	T	TL	TL	L	T		T	L	T
V	29	M	S	C	M	M		M	S	M	M	D	M	M	M		D	M	D	T	TL	TL	L	T		T	L	T
	30	M	S	C	M	M		M	S	M	M	D	M	M	M		D	M	D	T	TL	TL	L	T		T	L	T
	31	M	S	C	M	M		M	S	M	M	D	M	M	M		D	M	D	T	TL	TL	L	T		T	L	T
	32	M	S	C	M	M		M	S	M	M	D	M	M	M		D	M	D	T	TL	TL	L	T		T	L	T
X	29	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	30	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	31	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	32	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
O	25	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L		L		L	L	M	L	TL	L		L		L	L	L
	26	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L		L		L	L	M	L	TL	L		L		L	L	L
	27	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L		L		L	L	M	L	TL	L		L		L	L	L
	28	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L		L		L	L	M	L	TL	L		L		L	L	L
Z	6	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	7	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	11	VC	VC	VC	VC	VC		C	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	111	M	S	M	M	M		M	S	M	M	M	M	M	M		M	M	D	L	T	TL	T	T		T	T	T
	112	M	S	M	M	M		M	S	M	M	M	M	M	M		M	M	D	L	T	TL	T	T		T	T	T
	113	M	S	M	M	M		M	S	M	M	M	M	M	M		M	M	D	L	T	TL	T	T		T	T	T
	209	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T	T	T		T	T	T
	213	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T	T	T		T	T	T
	214	S	VS	S	S	S		S	S	S	M	D	D	M	M		D	M	D	T	T	T	T	T		T	T	T
	310	VS	VS	VS	VS	VS		S	VS	S	M	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T

ROW No. 3

Mark	Sheet No.	Texture									Color									Adherence								
		1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
AA	25	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	26	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	27	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	28	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	29	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	30	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
AA*	50	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	51	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	52	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	53	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	54	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	55	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
	56	VC	VC	VC	VC	VC		VC	VC	VC	L	M	L	L	L		L	M	M	L	L	L	L	L		L	L	L
BB	22	C	C	M	M	C		M	M	M	M	M	L	L	L		L	L	M	L	L	TL	T	T		T	L	T
	23	C	C	M	M	C		M	M	M	M	M	L	L	L		L	L	M	L	L	TL	T	T		T	L	T
	24	C	C	M	M	C		M	M	M	M	M	L	L	L		L	L	M	L	L	TL	T	T		T	L	T
	40	M	M	S	M	M		M	M	M	M	D	M	D	D		M	M	D	L	TL	TL	T	T		T	L	T
	41	M	M	S	M	M		M	M	M	M	D	M	D	D		M	M	D	L	TL	TL	T	T		T	L	T
BB*	33	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	34	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	35	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	36	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	50	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	51	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	52	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
	53	M	M	S	M	M		M	S	M	M	D	M	M	M		M	M	M	M	TL	TL	T	T		T	L	T
CC	7	C	C	M	C	M		M	M	M	M	L	M	M	M		M	M	M	M	L	TL	T	T		T	L	T
	19	C	C	M	C	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
CC*	31	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
	32	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
	33	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
	34	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
	35	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
	36	C	C	M	M	M		M	M	M	M	L	M	M	M		L	M	M	M	L	TL	T	T		T	L	T
DD	8	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	9	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	10	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	29	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	30	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	31	C	C	M	C	C		M	C	C	M	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
DD*	47	C	C	M	C	C		M	M	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	48	C	C	M	C	C		M	M	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	49	C	C	M	C	C		M	M	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	54	C	C	M	C	C		M	C	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	55	C	C	M	C	C		M	C	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	56	C	C	M	C	C		M	C	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	57	C	C	M	C	C		M	C	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
	58	C	C	M	C	C		M	C	C	L	L	L	L	L		L	L	L	M	L	TL	L	L		T	L	T
EE†	17	S	S	M	M	S		S	M	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	L	T
	18	S	S	M	M	S		S	M	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	L	T
EE*	31	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	32	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	33	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	34	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	35	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	37	S	S	M	M	M		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
HH	23	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	24	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	25	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	26	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
HH*	43	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	44	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	45	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	46	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	47	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	48	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
	49	M	S	M	M	S		S	S	M	M	M	M	M	M		D	M	D	T	T	T	T	T		T	L	T
II	24	S	VS	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	25	S	VS	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	27	S	VS	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	28	S	VS	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	29	S	VS	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T

ROW No. 4 (cut off at the page edge): II*, KK, KK*, MM, SS, TT, UU, VV

— INSPECTION COMMITTEE —

CONDITION OF RUST.

Texture	Color	Adherence
VS—Very Smooth	L—Light	T—Tight
S—Smooth	M—Medium	L—Loose
M—Medium	D—Dark	
C—Coarse		
VC—Very Coarse		

J. H. Gibboney, Chairman — Norfolk & Western Ry. Co.
J. A. Aupperle, — American Rolling Mill Co.
D. M. Buck, — — American Sheet & Tin Plate Co.
W. A. Cooper, — Alan Wood Iron & Steel Co.
W. R. Fleming, — The Andrews Steel Co.
D. J. McAdam, Jr. — U.S. Navy, Bureau Steam Engineering.
M. E. Mc Donnell, — Pennsylvania Railroad Co.
H. E. Smith, — New York Central Railroad Co.
F. B. Wheaton, — U.S. Army, Quartermaster's Corps.

— AUPPERLE —

Notes:— O 25 to 28 inc., Failure.
A 38 " "
A 40 " 47 " "
O 29 " 36 " "
Failure Refers to one or more Holes due to Corrosion.

Notes:- A 31 Very
S 29 to 32 in
X 29
O 25 to 28 "
Z 6 & 7
Z 11 Failure
AA 25 to 30 i
A 35 to 47 "
S 36 " 42
X 33 " 42
O 29 " 36
S 35 Failur

TABLE V.—RESULTS OF INSPECTION OF CORROSION TEST SHEETS, AT PITTSBURGH,

AMERICAN SOCIETY FOR TESTING MATERIALS
COMMITTEE A-5 ON CORROSION OF IRON AND STEEL
TESTS OF UNCOATED SHEETS
PITTSBURGH, PA.

EXPOSED DECEMBER 12, 1916

ROW No. 4 — Designation; Condition of Rust (Texture, Color, Adherence)

Lot	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
II*	48	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	49	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	50	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	51	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	52	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	53	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	54	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	55	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	56	VS	VS	VS	S	VS		S	VS	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
KK	28	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	29	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	30	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	31	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	32	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	33	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	34	S	S	S	M	S		S	S	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
KK*	51	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	52	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	53	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	54	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	55	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	56	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	57	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	58	VS	VS	VS	S	S		S	S	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
MM†	33	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	34	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	35	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	36	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	37	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	38	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	39	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	40	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	41	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
	42	C	C	C	C	C		M	M	C	M	L	L	L	M		M	L	M	L	L	TL	L	L		T	L	T
SS	33	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	34	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	35	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	36	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	37	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	38	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	39	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	40	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	41	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
	42	C	C	VC	VC	VC		C	C	C	M	L	L	L	L		L	L	M	L	L	L	L	L		L	L	T
TT	33	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	34	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	35	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	36	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	37	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	38	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	39	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	40	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	41	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
	42	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	TL	T	T	T		T	L	T
UU	33	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	34	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	35	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	36	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	37	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	38	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	39	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	40	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	41	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
	42	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	T	T
VV	43	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	44	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	45	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	46	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	47	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	48	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	49	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	50	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T
	51	M	S	M	M	M		S	S	M	M	M	M	M	M		D	M	M	M	T	TL	T	T		T	L	T

ROW No. 5

Lot	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
XX	33	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	34	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	35	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	36	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	37	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	38	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	39	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	40	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	41	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
	42	C	C	VC	C	C		C	M	C	M	L	L	M	L		L	L	M	L	L	L	L	L		L	L	L
ZZ	208	VS	VS	S	VS	S		S	VS	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	209	VS	VS	S	VS	S		S	VS	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	213	VS	VS	S	VS	S		S	VS	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	314	VS	VS	S	VS	S		S	VS	S	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	425	C	M	M	M	C		C	M	C	L	M	L	L	M		L	L	L	L	L	TL	T	L		L	L	T
	427	C	M	M	M	C		C	M	C	L	M	L	L	M		L	L	L	L	L	TL	T	L		L	L	T
	807	M	S	S	S	S		M	S	M	M	M	M	M	D		D	D	M	T	T	T	T	T		T	T	T
	510	M	S	S	S	S		M	S	M	M	M	M	M	D		D	D	M	T	T	T	T	T		T	T	T
	509	M	S	S	S	S		M	S	M	M	M	M	M	D		D	D	M	T	T	T	T	T		T	T	T
	612	M	VS	VS	VS	S		S	S	S	M	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	614	S	VS	VS	VS	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	615	S	VS	VS	VS	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	714	S	VS	VS	VS	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	715	S	VS	VS	VS	S		S	S	S	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
OO	29	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	30	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	31	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	32	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	33	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	34	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	35	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
	36	VC	C	VC	VC	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	TL
CCC	5	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	6	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	7	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	8	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	9	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	10	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	11	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
	12	M	M	M	M	M		M	S	M	M	M	M	D	M		M	M	M	T	T	T	T	T		T	L	T
A	35	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	36	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	37	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	38	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	39	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	40	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	41	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	42	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	43	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	44	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	45	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	46	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	L
	47	VC	VC	VC	VC	VC		VC	VC	VC	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
B	21	M	S	S	S	S		M	S	M	M	M	M	M	M		M	M	M	T	T	T	T	T		T	L	T
	22	M	S	S	S	S		M	S	M	M	M	M	M	M		M	M	M	T	T	T	T	T		T	L	T
	23	M	S	S	S	S		M	S	M	M	M	M	M	M		M	M	M	T	T	T	T	T		T	L	T
	24	M	S	S	M	S		M	S	C	M	D	M	M	M		D	M	M	T	TL	T	T	T		T	L	T
	25	M	M	M	M	S		M	S	C	M	M	M	M	M		M	M	M	T	TL	T	T	T		T	L	T
	26	M	M	M	M	S		M	M	C	M	M	M	M	M		M	M	M	T	TL	T	T	T		T	L	T
	27	M	M	M	M	S		M	M	C	M	M	M	M	M		M	M	M	T	TL	T	T	T		T	L	T
	28	M	M	M	M	S		M	S	C	M	M	M	M	M		M	M	M	T	TL	T	T	T		T	L	T
	29	M	S	M	M	S		M	S	C	M	D	M	M	M		M	M	M	T	T	T	T	T		T	L	T
C	30	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	31	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	32	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	32	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	33	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	34	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T
	35	C	M	M	M	M		M	S	M	L	M	M	M	M		M	M	M	T	T	TL	T	T		T	L	T

ROW No. 6

Lot	Sheet No.	Texture: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Color: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton	Adherence: 1 Aupperle	2 Buck	3 Cooper	4 Fleming	5 Gibboney	6 McAdam	7 McDonnell	8 Smith	9 Wheaton
D	35	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	36	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	38	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	39	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	40	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
L	29	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	30	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	31	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	32	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	33	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	34	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	35	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	36	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
H	43	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	45	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	47	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	49	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	50	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	53	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	54	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	55	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
I	42	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	43	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	44	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	45	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	46	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	47	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	48	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	49	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	50	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	51	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	52	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	53	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	54	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	55	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
K	37	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	38	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	39	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	40	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	41	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	42	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	43	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	44	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	45	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	46	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	47	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	48	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
M	33	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	34	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	35	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	36	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	37	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	38	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	39	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	40	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	41	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	42	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
N	33	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	34	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	35	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	36	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	37	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	38	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	39	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	40	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	41	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	42	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T

* [illegible]
† [illegible]

— BUCK —

Notes:—A 31 Very near Failure.
S 29 to 32 inc. Very near Failure.
X 29 Near "
O 25 to 28 " Failure. Sheets Ragged and in Holes.
Z 6 & 7 Near Failure.
Z 11 Failure. S 33 & 34 Very near Failure.
AA 25 to 30 inc. weak. AA* 50 to 56 inc. weak.
A 35 to 47 " Failure, Ragged Edges.
S 36 " 42 " Very near Failure.
X 33 " 42 " " " "
O 29 " 36 " Failure.
S 35 Failure.

Panel "O" in worse Condition. Complete Failure; Sheets Ragged and in Holes.
Panels "A" & "S" Next worst Condition. Failure.
Panel "X" " " " . Very near Failure.
" "D" " " " . Corroding Fast.
Certain Sheets in lot "Z" also near Failures and Failures.
Hole punched accidentally in Sheet I-50, Ninth Valley 2/3 way up.
Hole punched accidentally in Sheet V-40, First Valley near Bottom.

— COOPER —

Notes:—AA 21 to 24 inc. Heavy Loose Scale all over Surface of Sheets.
A 33 Ragged Cut Bottom.
A 34 Slightly Bent at Rail.
D 30 to 34 inc. Loose Scale on Surface of Sheets.
S 29 " 32 " " " " " " "
X 32 Break just below Rail.
O 25 to 28 inc. Failed. All Ragged at Bottom.
O 26 Hole below Rail Covered with Loose Scale.
Z 6, 7 & 11 near Failure.
AA 25 to 30 inc. Covered with Loose Scale on Surface of Sheets.
AA* 50 to 56 inc. Covered with Loose Scale on Surface of Sheets.

X 33 to 42 inc. Scale on Surface of Sheets.
SS 33 to 42 " Loose Scale on Surface of Sheets.
A 35 " 47 " " " " " " "
A 37 & 38, 40 & 41, 43 & 44 Ragged in Bottom.
I 50 Hole Punched from Bottom, - Ninth Corrugation.
S 33 to 42 inc. Loose Scale on Surface of Sheets.
S 35 Cracked. Sixth Corrugation 5" from Bottom of Sheet.
O 29 to 36 inc. Failed. All Ragged in Bottom.
V 40 Hole punched below L.H. Lower Corner.
Sheets "O" failed.
" "A" near Failure.
" "S" " "
" "Z" 6, 7 & 11 near Failure.

— FLEMING

Notes: A 31 to 34 inc. She
but no Failures. O
X 29 to 32 inc. Ver
AA 25 to 30 " "
AA* 50 – 56 " "
O 29 to 36 " Fa
A 37 & 38, 40
T 39 to 42 " Bo
Z 607 to 609 inc
Thrown across.

CORROSION TEST SHEETS, AT PITTSBURGH, PA., APRIL 9, 1918.

N SOCIETY FOR TESTING MATERIALS

MITTEE A-5 ON CORROSION OF IRON AND STEEL

TESTS OF UNCOATED SHEETS

PITTSBURGH, PA.

EXPOSED DECEMBER 12, 1916

Weather *Cloudy.*

Color 9	Adh. 1	2	3	4	5	6	7	8	9
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
M	L	L	L	L	L		L	L	L
D	T	T	T	T	T		T	T	T
D	T	T	T	T	T		T	T	T
D	T	T	T	T	T		T	T	T
D	T	T	T	T	T		T	T	T
L	L	L	TL	T	L		L	L	T
L	L	L	TL	T	L		L	L	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	T	T	T	T	T		T	T	T
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	L	L	L	L	L		L	L	TL
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	L	L	L	L	L		L	L	L
	L	L	L	L	L		L	L	L
	L	L	L		L		L	L	L
	L	L	L		L		L	L	L
	L	L	L	L	L		L	L	L
	L	L	L		L		L	L	L
	L	L	L		L		L	L	L
	L	L	L	L	L		L	L	L
	L	L	L		L		L	L	L
	L	L	L		L		L	L	L
	L	L	L	L	L		L	L	L
	L	L	L		L		L	L	L
	L	L	L	L	L		L	L	L
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	TL	T	T	T		T	L	T
	T	TL	T	T	T		T	L	T
	T	TL	T	T	T		T	L	T
	T	TL	T	T	T		T	L	T
	T	TL	T	T	T		T	L	T
	T	T	T	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T
	T	T	TL	T	T		T	L	T

ROW No. 6

Condition of Rust. Inspectors: 1 Aupperle, 2 Buck, 3 Cooper, 4 Fleming, 5 Gibboney, 6 McAdam, 7 McDonnell, 8 Smith, 9 Wheaton.

Designation: Row	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
D	35	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	36	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	38	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	39	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
	40	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	L	T	L	L	L	L		L	L	T
L	29	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	30	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	31	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	32	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	33	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	34	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	35	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
	36	S	S	M	M	M		S	S	M	M	D	D	D	D		D	M	M	T	T	T	T	T		T	L	T
H	43	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	45	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	47	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	49	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	50	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	53	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	54	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
	55	S	S	S	M	S		S	S	M	M	D	D	M	M		D	M	M	T	T	T	T	T		T	L	T
J	62	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	63	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	64	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	65	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	66	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	67	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	68	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	69	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	50	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	51	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	52	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	53	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	54	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	55	S	VS	S	S	S		S	VS	SM	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
K	37	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	38	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	39	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	40	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	41	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	42	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	43	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	44	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	45	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	46	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	47	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
	48	S	VS	S	S	S		S	VS	M	D	D	D	D	D		D	M	D	T	T	T	T	T		T	T	T
M	33	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	34	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	35	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	36	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	37	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	38	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	39	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	40	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	41	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
	42	M	M	S	M	M		M	S	M	M	M	D	D	M		D	M	D	T	T	T	T	T		T	T	T
S	33	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	34	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	35	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	36	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	37	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	38	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	39	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	40	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	41	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T
	42	C	VC	C	VC	C		C	M	C	M	L	L	L	L		L	M	M	L	L	L	L	L		L	L	T

ROW No. 7

Designation: Row	Sheet No.	Texture 1	2	3	4	5	6	7	8	9	Color 1	2	3	4	5	6	7	8	9	Adherence 1	2	3	4	5	6	7	8	9
T	33	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	34	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	35	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	36	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	37	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	38	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	39	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	40	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	41	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
	42	M	S	M	S	S		M	S	S	M	D	M	D	D		D	M	M	T	T	T	T	T		T	T	T
U	33	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	34	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	35	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	36	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	37	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	38	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	39	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	40	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	41	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
	42	M	S	M	M	M		S	S	M	M	M	M	D	M		D	M	M	T	T	T	T	T		T	T	T
V	33	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	34	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	35	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	36	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	37	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	38	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	39	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	40	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	41	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
	42	M	M	M	M	S		S	S	M	M	M	M	M	M		D	M	M	T	T	T	T	T		T	T	T
X	33	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	34	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	35	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	36	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	37	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	38	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	39	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	40	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	41	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
	42	C	VC	VC	VC	VC		C	C	VC	L	L	L	L	L		L	L	L	L	L	L	L	L		L	L	L
Z	314	VS	VS	VS	S	VS		VS	VS	S	M	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	422	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	423	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	424	C	C	VC	C	C		C	M	C	L	L	L	L	L		L	L	M	L	L	L	L	L		L	L	L
	508	S	S	S	S	M		S	S	M	M	D	D	M	D		D	M	D	T	T	T	T	T		T	T	T
	513	S	S	S	S	S		S	S	M	M	D	D	M	D		D	M	D	T	T	T	T	T		T	T	T
	516	S	S	S	S	S		S	S	M	M	D	D	M	D		D	M	D	T	T	T	T	T		T	T	T
	607	S	VS	S	S	S		S	S	M	M	D	D	M	D		D	M	M	T	T	T	T	T		T	T	T
	608	S	VS	S	S	S		S	S	M	M	D	D	M	D		D	M	M	T	T	T	T	T		T	T	T
	609	S	VS	S	S	S		S	S	M	M	D	D	M	D		D	M	M	T	T	T	T	T		T	T	T
	712	VS	VS	VS	M	S		S	VS	SM	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	714	VS	VS	VS	M	S		S	VS	SM	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
	715	VS	VS	VS	M	S		S	VS	SM	D	D	D	D	D		D	D	D	T	T	T	T	T		T	T	T
O	29	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	30	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	31	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	32	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	33	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	34	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	35	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
	36	VC	VC	VC		VC		VC	VC	VC	L	L	L		L		L	L	M	L	L	L		L		L	L	T
Y	7	C	S	S	S	M		M	M	M	L	L	L	L	L		L	L	L	L	T	T	L	T		T	T	T
	8	C	S	S	S	M		M	M	M	L	L	L	L	L		L	L	L	L	T	T	L	T		T	T	T
	9	C	S	S	S	M		M	M	M	L	L	L	L	L		L	L	L	L	T	T	L	T		T	T	T
YY	7	C	M	M	S	M		M	M	M	L	L	L	L	L		L	L	L	L	TL	T	L	L		T	T	T
	8	C	M	M	S	M		M	M	M	L	L	L	L	L		L	L	L	L	TL	T	L	L		T	T	T
	9	C	M	M	S	M		M	M	M	L	L	L	L	L		L	L	L	L	TL	T	L	L		T	T	T

— COOPER —

avy Loose Scale

f Sheets.

Bottom.

at Rail.

e Scale on Surface of Sheets.

" " " " "

below Rail.

d. All Ragged at Bottom.

l Covered with Loose Scale

lure.

vered with Loose Scale

ts.

vered with Loose Scale

ets.

X 33 to 42 inc. Scale on Surface of Sheets.
SS 33 to 42 " Loose Scale on Surface of Sheets.
A 35 " 47 " " " " " "
A 37 & 38, 40 & 41, 43 & 44 Ragged in Bottom.
I 50 Hole Punched from Bottom, - Ninth Corrugation.
S 33 to 42 inc. Loose Scale on Surface of Sheets.
S 35 Cracked. Sixth Corrugation 5" from Bottom of Sheet.
O 29 to 36 inc. Failed. All Ragged in Bottom.
V 40 Hole punched below L.H. Lower Corner.
Sheets "O" failed.
" "A" near Failure.
" "S" " "
" "Z" 6, 7 & 11 near Failure.

— FLEMING —

Notes: A 31 to 34 inc. Sheets in bad Condition, but no Failures. O 25 to 28 inc. Failed.
X 29 to 32 inc. Very bad Condition, but no Failures.
AA 25 to 30 " " " " " " "
AA* 50 - 56 " " " " " " "
O 29 to 36 " Failed.
A 37 & 38; 40 & 41; 43, 44, 46 Failed.
T 39 to 42 " Boards Piled against Top of Sheets.
Z 607 to 609 inc. Boards and Canvass Thrown across.

— GIBBONEY —

Notes: — A 33 Failed End.
S 32 " "
X 31 Very near Failure – Bent–Hole.
O 25 to 28 inc. Failure.
Z 11 Failure.
I 50 Hole, Damaged.
A 35 to 47 inc. Failure.
S 35 Failure.

— McADAM —

Note: Did not make this Inspection.

Notes:

...ake
...tion.

— MC DONNELL —

Notes: — MM* 29 to 32 inc. - Adherence approaching loose.
A 31 to 34 inc. Plates thin, Estimated 50% loss.
D 30 " 34 " " " " 40% "
S 29 " 32 " " " " 50% "
X 29 " 32 " " " " 50% "
O 25 " 28 " " " " 75% "
A 35 " 47 " " " " 50% "
S 33 " 42 " " " " 40% "
O 29 " 36 " " " " 75% "
H 38 " 42 " Adherence approaching loose.
M 29 " 32 " " moderately "
BB 22 " 41 " " approaching "
CC 7 & 19 " " "

CC* 31 to 36 inc. Adherence approaching loose.
DD 8 & 9 Texture " coarse.
DD 10, 29, 30 & 31 Adherence " loose.
DD* 47 to 58 inc. " " "
MM† 33 " 42 " " " "
B 21 " 39 " " " "
II* 48 " 56 " Smooth to very Smooth.
UU 33 " 42 " Texture " " " "
VV 43 " 51 " " " " " "
CCC 5 " 12 " Color - medium, approaching dark.
T 33 " 42 " Texture " to Smooth.
X 33 " 42 " " Coarse to very Coarse.

— SMITH —

Notes. - A 33 Ragged from Corrosion, Bent.
O 25 to 28 inc. Ends Ragged.
O 26 Hole near Left Corner.
A 37, 38, 40, 41 & 43 Ends Ragged.
A 43 Hole near Lower End, - Due to Mechanical Injury.
I 50 Hole, Mechanical Injury.
S 35 Small Rust Hole near Bottom.
O 29-36 inc. Lower Ends Ragged.
O 29 Lower End Bent down.

— WHEATON —

Notes: - A 21 to 24 inc. Scale Trace. S 29 to 32 inc. Scale.
X 29 " 32 " " " AA 25 " 30 " "
O 25 " 28 " " Failed. AA* 50 " 56 "
S 33 & 34 " Trace. YY* 7 " 9 " "
S 37 to 42 " " " Y* 7 " 9 " Scale Trace.
A 35 " 47 " " " — near Failure.
S 34 " 42 " " "
X 33 " 42 " " "
Z 607 to 609 inc. Partly Covered by Lumber & Canvass.
O 29 " 36 " Scale, Failed Lower Edge.

Jas. H. Gibboney
Chairman Inspection Committee

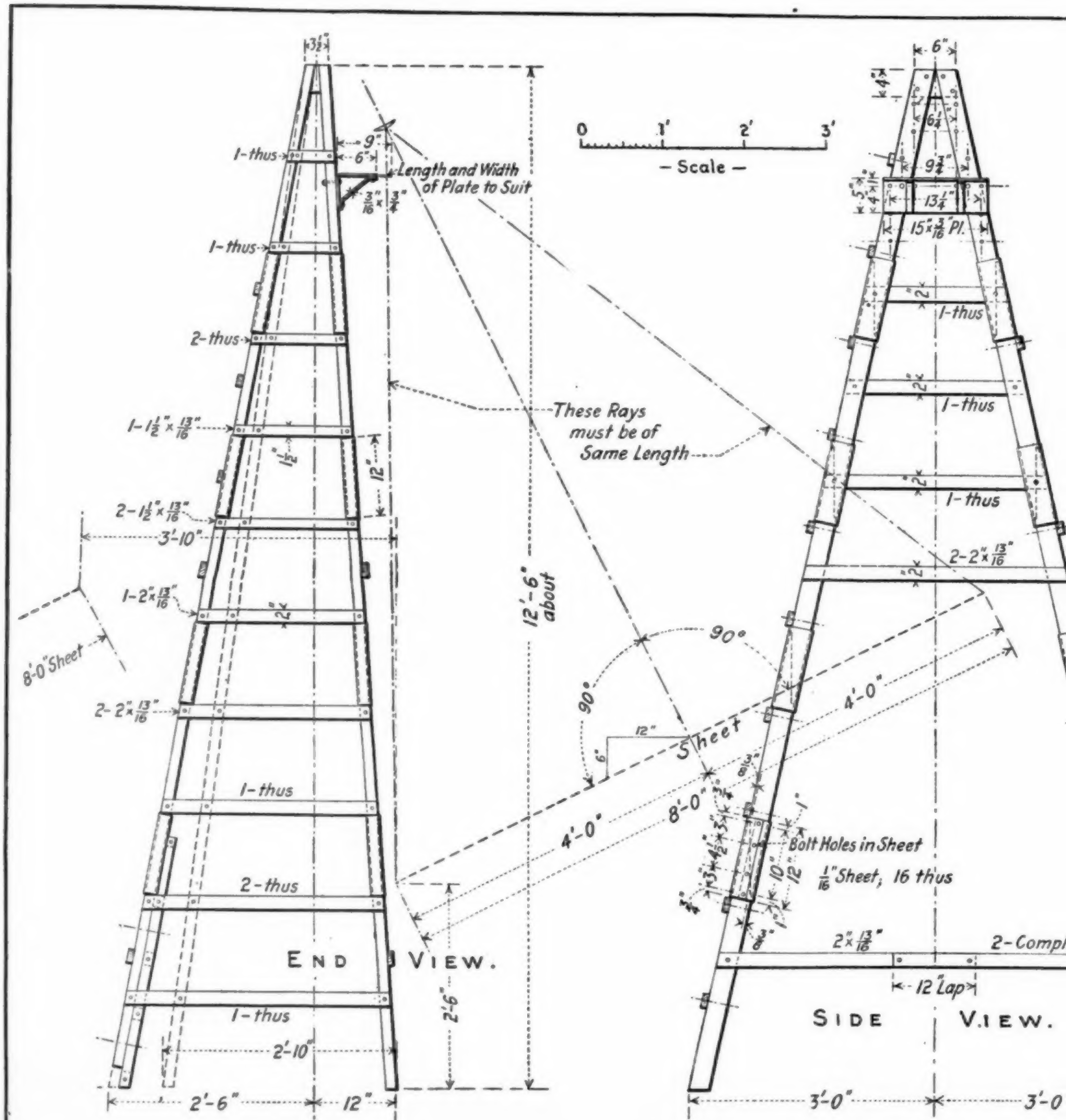
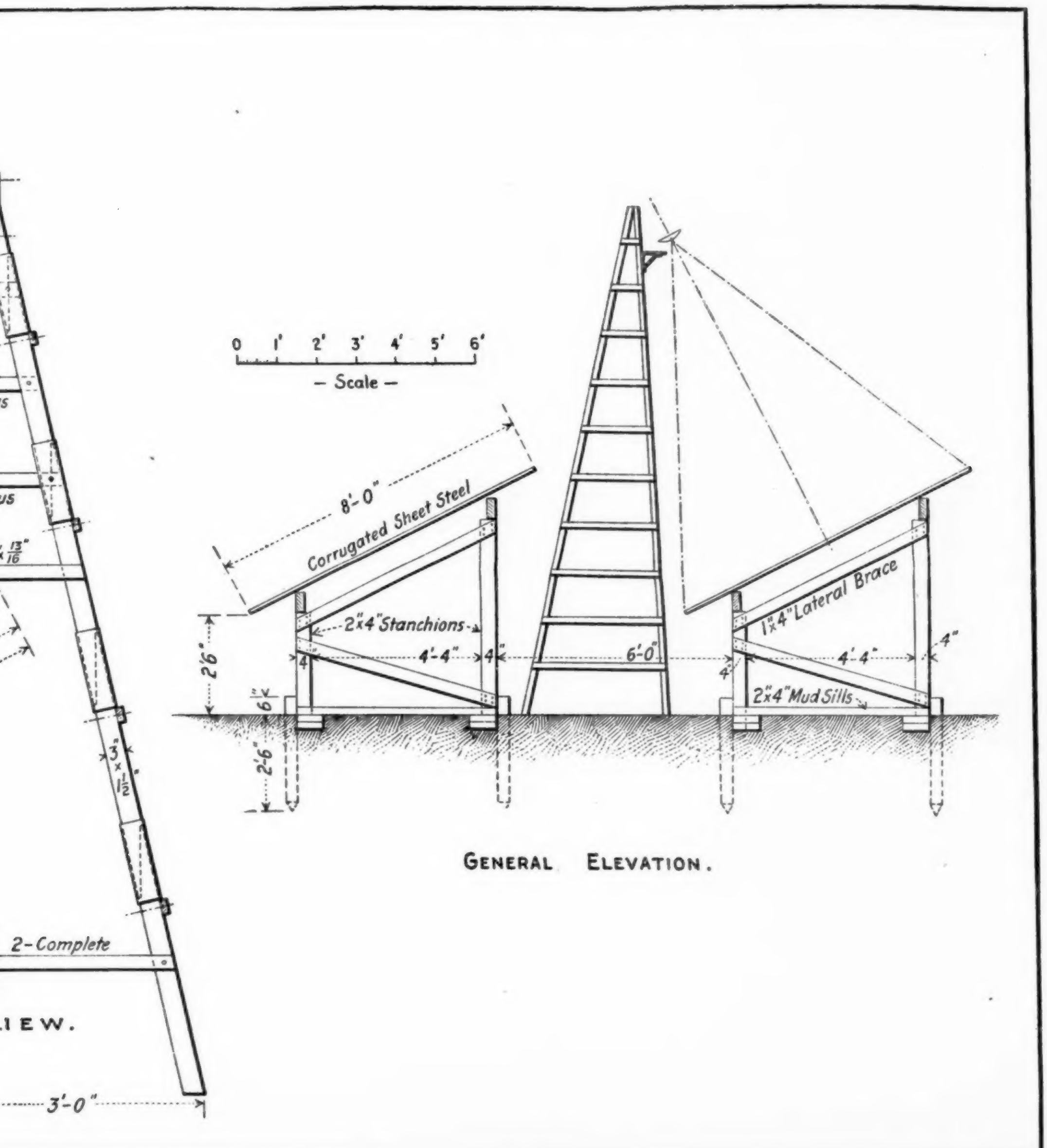


FIG. 3.—PHOTOGRAPH

PLATE VI.
PROC. AM. SOC. TEST. MATS.
VOL. XVIII, PART I.
REPORT OF COMMITTEE A-5:
CORROSION TESTS.



TOGRAPHIC TOWER.

the texture, color and adherence of the rusted surfaces were adopted and have been carried into a series of standard forms for recording, transmitting and compiling the inspection data. These forms are shown as Figs. 1 and 2, and in the insert Tables I–V.

Fig. 1 shows the loose leaf inspector's data sheet, with standard heading and separate series for each test location. The sheets are arranged to run in the order of appearance of the metal sheets in the test; the pages are numbered in the right-hand corner, the number being preceded by letters indicating location of test.

Fig. 2 shows the standard form used by the inspectors in transmitting data from loose-leaf records to the chairman for compilation.

Table I shows the standard report form for compiling all inspection data for ready comparisons. This form after preparation is used in making blueprints for distribution to the committee for consideration.

The second meeting of the committee was held at Fort Sheridan, Ill., on October 8, 1917, with Messrs. Aupperle (representing Mr. A. S. Cushman), Buck, Cooper, Fleming, McDonnell, Smith, Wheaton and Gibboney present, the representative of the Bureau of Steam Engineering of the U. S. Navy Department being absent.

The Fort Sheridan sheets were inspected on October 8, 1917, followed by the Pittsburgh sheets on October 9, 1917, and the Annapolis sheets on October 10, 1917. At the Annapolis inspection the committee was joined by the representative of the Bureau of Steam Engineering of the U. S. Navy Department. Mr. S. S. Voorhees, *ex officio* member of the committee, was present at the Pittsburgh and Annapolis inspections.

The results of these inspections are shown in composite form as Tables I, II and III, Plates I–III, inclusive.

At these inspections it was decided to arrange for suitable photographic records of failed sheets at their first appearance of failure and this arrangement has been made through the cooperation of the Norfolk and Western Railway. Camera support for obtaining negatives of sheets on inclined rack without distortion has been devised along the lines illustrated in Fig. 3, Plate VI.

The third meeting of the committee was held at Fort Sheridan, Ill., on April 8, 1918, with Messrs. Aupperle (representing Mr. A. S. Cushman), Buck, Cooper, Fleming, McDonnell, Smith, Wheaton, Gibboney and Voorhees (*ex officio*) present, the representative of the Bureau of Steam Engineering of the U. S. Navy Department being absent.

The Fort Sheridan sheets were inspected on April 8, 1918, followed by the Pittsburgh sheets on April 9, 1918. On account of rain at Annapolis, on April 10, a detail inspection of the sheets was not made; however, we can record the appearance of these sheets as not materially different from their appearance at the October, 1917, inspection.

The results of the Fort Sheridan and Pittsburgh inspections are shown in composite form as Tables IV and V, Plates IV and V.

In order to present some condensed results of the various inspections, tables have been prepared from the composite reports by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have then been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse
1.8 " 2.6	Coarse
2.6 " 3.4	Medium
3.4 " 4.2	Smooth
4.2 " 5.0	Very smooth

In the case of color and adherence it was impractical to ascribe satisfactory numerical values; therefore the symbols in the tables represent the majority opinions of the inspectors.

Tables VI, VII, VIII, IX and X give in condensed form the results obtained by the averaging method for the condition of surfaces of sheets at Fort Sheridan, Pittsburgh and Annapolis in October, 1917, and at Fort Sheridan and Pittsburgh in April, 1918, respectively.

TABLE VI.—FORT SHERIDAN TESTS. INSPECTION OF OCTOBER 8, 1917.

Type Designation.	Average Texture.		Color.	Adherence.
	Numerical Value.	Symbol.		
No. 16 Gage.				
BB	3.765	S	M	T
II	3.763	S	M	T
KK	3.750	S	M	T
HH	3.500	S	M	T
DD	3.369	M	M	T
UU	3.346	M	M	T
VV	3.217	M	M	T
ZZ (HC)	3.204	M	M	T
TT	3.187	M	D	T
EE	3.156	M	M	T
CC	3.031	M	M	T
XX	2.750	M	M	T
SS	2.625	M	M	T
OO	2.511	C	M	T
YY	2.500	C	L	T
CCC	2.479	C	M	T
MM	2.348	C	M	T
ZZ (LC)	2.250	C	M	T
AA	1.577	V C	L	L
AA (sand blasted)	....	....	M	L
No. 22 Gage.				
Z (HC)	4.000	S	M	T
I	3.694	S	M	T
B	3.529	S	M	T
H	3.500	S	M	T
T	3.447	S	M	T
K	3.414	S	M	T
V	3.331	M	M	T
M	3.295	M	M	T
C	3.261	M	M	T
D	3.125	M	M	T
E	3.081	M	M	T
U	2.884	M	M	T
Z (LC)	2.833	M	M	L
S	2.759	M	M	T
X	2.536	C	M	T
O	1.895	C	M	L
A	1.854	V C	L	L

NOTE.—LC indicates low copper.
HC indicates copper content from 0.12 to 0.674 per cent.

The above table has been compiled from the composite inspection report by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse (VC)
1.8 " 2.6	Coarse (C)
2.6 " 3.4	Medium (M)
3.4 " 4.2	Smooth (S)
4.2 " 5.0	Very smooth (VS)

In the case of color and adherence, it being impractical to ascribe satisfactory numerical values, the symbols in the table represent the majority opinions of the inspectors.

TABLE VII.—PITTSBURGH TESTS. INSPECTION OF OCTOBER 9, 1917.

Type Designation.	Average Texture.		Color.	Adherence.
	Numerical Value.	Symbol.		
No. 16 Gage.				
HH	3.725	S	D	T
ZZ (HC)	3.684	S	M	T
II	3.597	S	M	T
TT	3.572	S	M	T
KK	3.428	S	M	T
UU	3.339	M	M	T
CCC	3.219	M	M	T
EE	3.208	M	D	T
BB	3.100	M	M	T
VV	3.087	M	M	T
CC	2.979	M	M	T
MM	2.857	M	D	T
DD	2.521	C	M	T
OO	2.167	C	M	T
ZZ (LC)	2.150	C	M	T
XX	1.996	C	M	L
SS	1.822	C	M	L
AA	1.162	V C	L	L
No. 22 Gage.				
Z (HC)	3.828	S	D	T
I	3.819	S	D	T
H	3.792	S	D	T
K	3.719	S	D	T
B	3.653	S	D	T
T	3.589	S	D	T
U	3.554	S	M	T
V	3.464	S	D	T
C	3.364	M	D	T
M	3.330	M	D	T
E	3.125	M	D	T
D	2.431	C	M	T
Z (LC)	2.142	C	M	L
S	1.893	C	M	L
X	1.491	V C	M	L
A	1.346	V C	M	L
O	1.209	V C	L	L

NOTE.—LC indicates low copper.
HC indicates copper content from 0.12 to 0.674 per cent.

The above table has been compiled from the composite inspection report by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse (VC)
1.8 " 2.6	Coarse (C)
2.6 " 3.4	Medium (M)
3.4 " 4.2	Smooth (S)
4.2 " 5.0	Very smooth (VS)

In the case of color and adherence, it being impractical to ascribe satisfactory numerical values, the symbols in the table represent the majority opinions of the inspectors.

TABLE VIII.—ANNAPOLIS TESTS. INSPECTION OF OCTOBER 10, 1917.

Type Desigantion.	Average Texture.		Color.	Adherence.
	Numerical Value.	Symbol.		
No. 16 Gage.				
II	3.563	S	D	T
KK	3.488	S	D	T
HH	3.466	S	D	T
ZZ (HC)	3.373	M	D	T
TT	3.199	M	D	T
BB	2.928	M	D	T
UU	2.913	M	M	T
CC*	2.861	M	L	T
DD	2.795	M	M	T
VV	2.786	M	M	T
MM	2.715	M	M	T
EE	2.695	M	M	T
CCC	2.666	M	M	T
ZZ (LC)	2.574	C	M	T
SS	2.357	C	L	L
XX	2.326	C	M	T
OO	2.315	C	M	T
AA**	1.815	C	L	L
*CC (sand blasted)	....	....	M	T
**AA (sand blasted)	....	....	M	L
No. 22 Gage.				
K	3.445	S	D	T
T	3.349	M	D	T
Z (HC)	3.315	M	D	T
I	3.264	M	D	T
H	3.111	M	D	T
B	2.908	M	M	T
M	2.905	M	M	T
U	2.801	M	M	T
V	2.627	M	M	T
C	2.584	C	M	T
S	2.381	C	L	L
E	2.283	C	M	T
D	2.270	C	M	T
A	2.222	C	M	L
Z (LC)	2.204	C	L	L
X	2.159	C	M	L
O	1.778	V C	M	L

NOTE.—LC indicates low copper.
HC indicates copper content from 0.12 to 0.674 per cent.

The above table has been compiled from the composite inspection report by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse (VC)
1.8 " 2.6	Coarse (C)
2.6 " 3.4	Medium (M)
3.4 " 4.2	Smooth (S)
4.2 " 5.0	Very smooth (VS)

In the case of color and adherence, it being impractical to ascribe satisfactory numerical values, the symbols in the table represent the majority opinions of the inspectors.

TABLE IX.—FORT SHERIDAN TESTS. INSPECTION OF APRIL 8, 1918.

Type Designation.	Average Texture.		Color.	Adherence.
	Numerical Value.	Symbol.		
No. 16 Gage.				
II	4.089	S	M	T
ZZ (HC)	4.011	S	D	T
KK	4.006	S	M	T
HH	3.875	S	D	T
BB	3.721	S	M	T
EE	3.594	S	M	T
VV	3.316	M	M	T
UU	3.307	M	M	T
TT	3.205	M	D	T
DD	3.053	M	M	T
CC	2.906	M	M	T
ZZ (LC)	2.625	M	L	T
YY	2.625	M	L	T
CCC	2.469	C	M	T
XX	2.348	C	M	T
MM	2.330	C	L	T
SS.	2.281	C	L	T
OO	2.234	C	L	T
AA	1.771	V C	L	L
AA (sand blasted)	....	..	M	T
No. 22 Gage.				
Z (HC)	4.250	V S	D	T
I	4.105	S	D	T
T	3.625	S	M	T
H	3.625	S	M	T
K	3.570	S	M	T
E	3.333	M	M	T
V	3.321	M	M	T
B	3.317	M	M	T
M	3.232	M	M	T
C	3.146	M	M	T
Z (LC)	3.042	M	M	L
D	2.875	M	L	T
U	2.875	M	M	T
Y	2.708	M	M	T
X	2.250	C	L	T
S	2.000	C	L	T
O	1.625	V C	L	L
A	1.550	V C	L	L

NOTE.—LC indicates low copper.
HC indicates copper content from 0.12 to 0.674 per cent.

The above table has been compiled from the composite inspection report by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse (VC)
1.8 " 2.6	Coarse (C)
2.6 " 3.4	Medium (M)
3.4 " 4.2	Smooth (S)
4.2 " 5.0	Very smooth (VS)

In the case of color and adherence, it being impractical to ascribe satisfactory numerical values, the symbols in the table represent the majority opinions of the inspectors.

TABLE X.—PITTSBURGH TESTS. INSPECTION OF APRIL 9, 1918.

Type Designation.	Average Texture. Numerical Value.	Average Texture. Symbol.	Color.	Adherence.
No. 16 Gage.				
II	4.389	V S	D	T
ZZ (HC)	4.266	V S	D	T
KK	4.171	S	D	T
HH	3.600	S	M	T
TT	3.589	S	M	T
EE	3.542	S	D	T
VV	3.529	S	M	T
UU	3.518	S	M	T
CCC	3.333	M	M	T
BB	3.037	M	M	T
YY	3.000	M	L	T
CC	2.812	M	M	T
MM	2.357	C	M	L
DD	2.215	C	L	L
XX	1.750	V C	L	L
SS	1.625	V C	L	L
ZZ (LC)	1.600	V C	L	L
OO	1.500	V C	L	L
AA	1.000	V C	L	L
No. 22 Gage.				
I	4.118	S	D	T
K	4.062	S	D	T
Z (HC)	4.008	S	D	T
H	3.572	S	M	T
T	3.482	S	M	T
V	3.304	M	M	T
E	3.250	M	D	T
Y	3.250	M	L	T
U	3.232	M	M	T
B	3.211	M	M	T
M	3.107	M	M	T
C	2.864	M	M	T
D	1.833	C	L	L
Z (LC)	1.803	C	L	L
S	1.625	V C	L	L
X	1.268	V C	L	L
A	1.000	V C	L	L
O	1.000	V C	L	L

NOTE.—LC indicates low copper.
HC indicates copper content from 0.12 to 0.674 per cent.

The above table has been compiled from the composite inspection report by averaging the reports on texture on each sheet by each inspector. The arbitrary figures used in these averages are as follows:

Very coarse	1
Coarse	2
Medium	3
Smooth	4
Very smooth	5

The numerical values thus obtained have been translated back into symbols, using the following scale:

1.0 to 1.8	Very coarse (VC)
1.8 " 2.6	Coarse (C)
2.6 " 3.4	Medium (M)
3.4 " 4.2	Smooth (S)
4.2 " 5.0	Very smooth (VS)

In the case of color and adherence, it being impractical to ascribe satisfactory numerical values, the symbols in the table represent the majority opinions of the inspectors.

Fig. 4 illustrates the general form of rack construction adopted for exposing the full-size sheets used in these tests. Some slight modifications were necessary to apply the construction to the three locations.

Figs. 5, 6 and 7 show the general views for the sheets as appearing on the racks at the test locations.

The following photographs of the Pittsburgh sheets were made on April 18, 1918, representing an exposure period of 16 months.

Figs. 8 to 14, inclusive, represent the condition of sheets A 31 to 47 inclusive (No. 22 Gage Bessemer Steel, Series A). All of these sheets, excepting No. 39, have failed as evidenced by either holes or ragged edges or both conditions.

Figs. 15 to 19 inclusive represent the condition of sheets O, 25 to 36 inclusive (No. 22 Gage Low-Copper Open-hearth Steel, Series A). All of these sheets have failed.

Figs. 20 to 25 inclusive represent the condition of sheets S 29 to 42 inclusive (No. 22 Gage Low-Copper Open-hearth Iron, Series B), being the "Armco" brand of open-hearth iron manufactured by the American Rolling Mill Company. Only sheet S 35 shows failure at this time, the failure being due to a small hole in the sheet at the sixth corrugation from the left hand side 5 inches from the bottom.

Fig. 26 represents the condition of sheets Z 6, 7 and 11 (No. 22 Gage Bessemer Steel, varying copper contents, Series B), manufactured by the Youngstown Sheet and Tube Co. Sheet Z 11 shows failure, as evidenced by ragged edges, while sheets Z 6 and 7 do not show failure at this time.

All of the sheets that have failed up to April 18, 1918, are shown in the above photographic records.

Fig. 27 represents the condition of sheets AA 50, 51 and 52 (No. 16 Gage Bessemer Steel, Series A) as appearing at Pittsburgh, April 18, 1918, illustrating "very coarse" texture and "loose" rust.

Fig. 28 represents the condition of sheets ZZ 208, 209 and 213 (No. 16 Gage Bessemer Steel, varying copper content, Series B), manufactured by the Youngstown Sheet and Tube Co., as appearing at Pittsburgh, April 18, 1918, illustrating "very smooth" texture and "tight" rust.

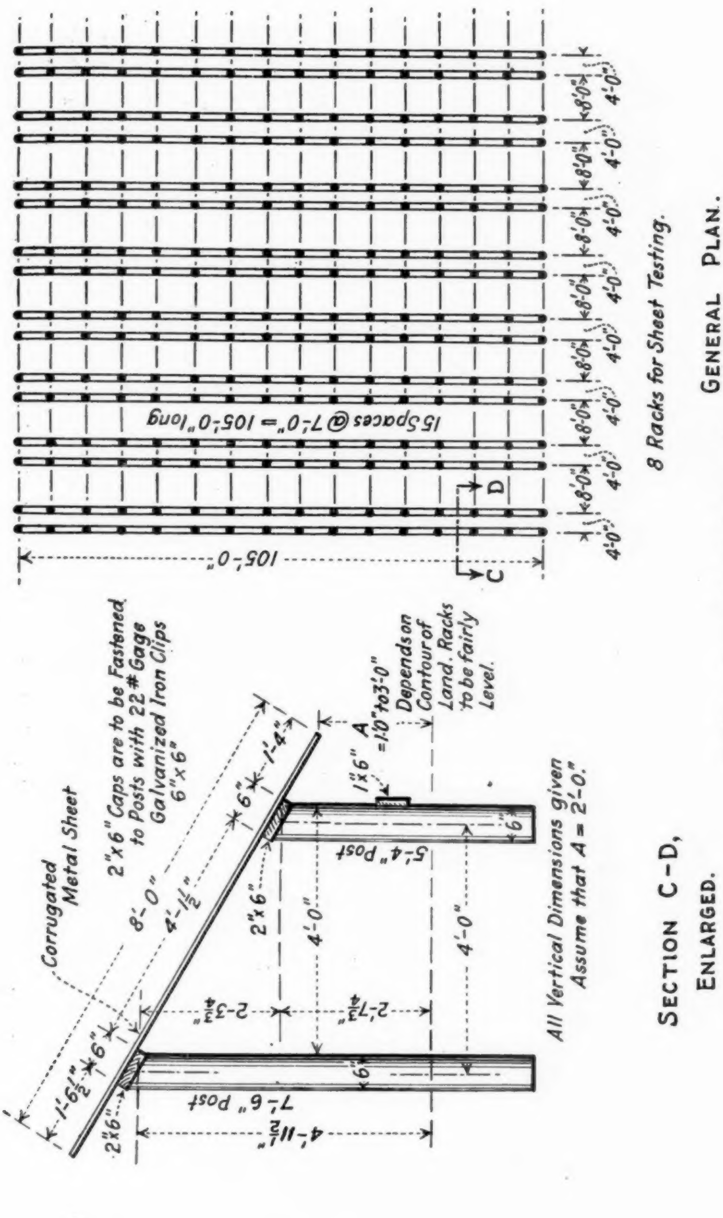


FIG. 4.—General Rack Construction.

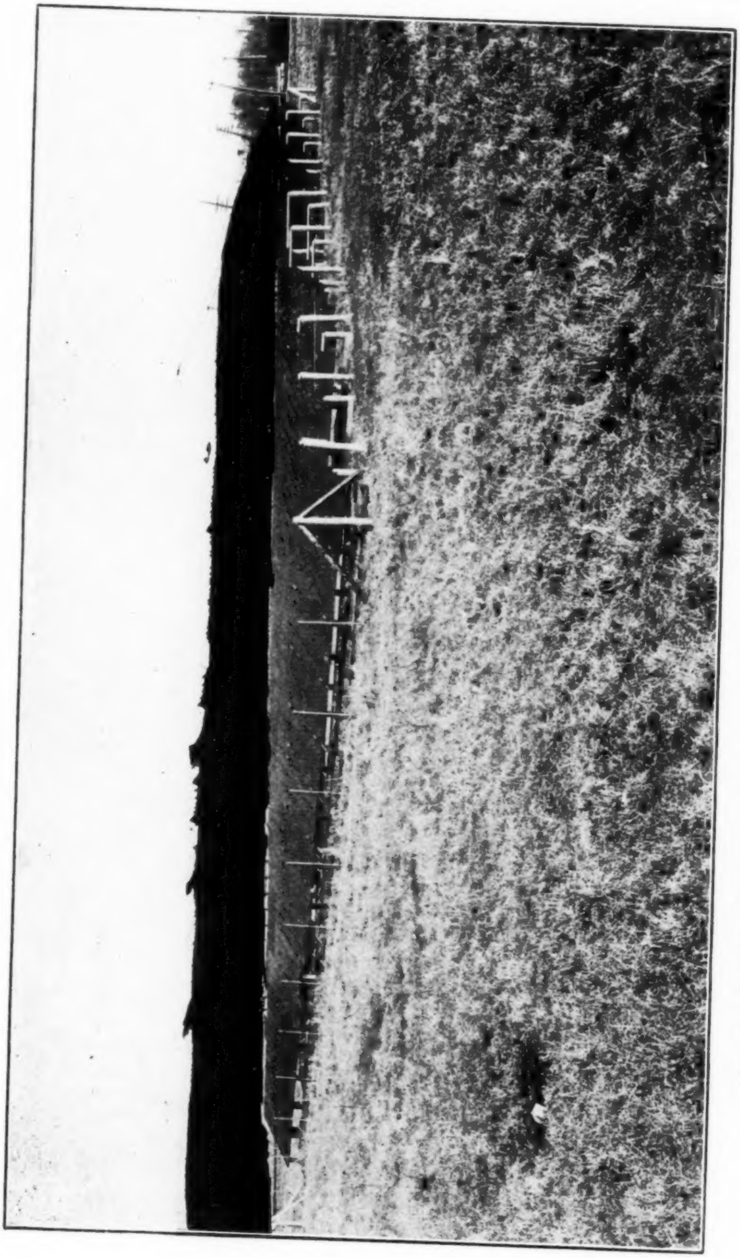


FIG. 5.—Fort Sheridan Tests. Sheets exposed April 9, 1917. Photographed April 24, 1918.

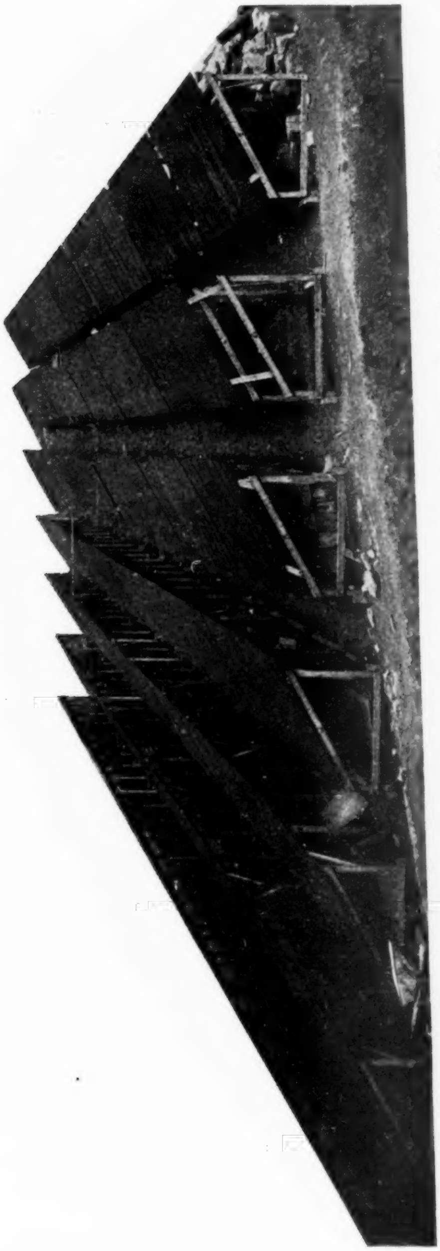


FIG. 6.—Pittsburgh Test Rack. Sheets exposed December 12, 1916. Photographed April 18, 1918.

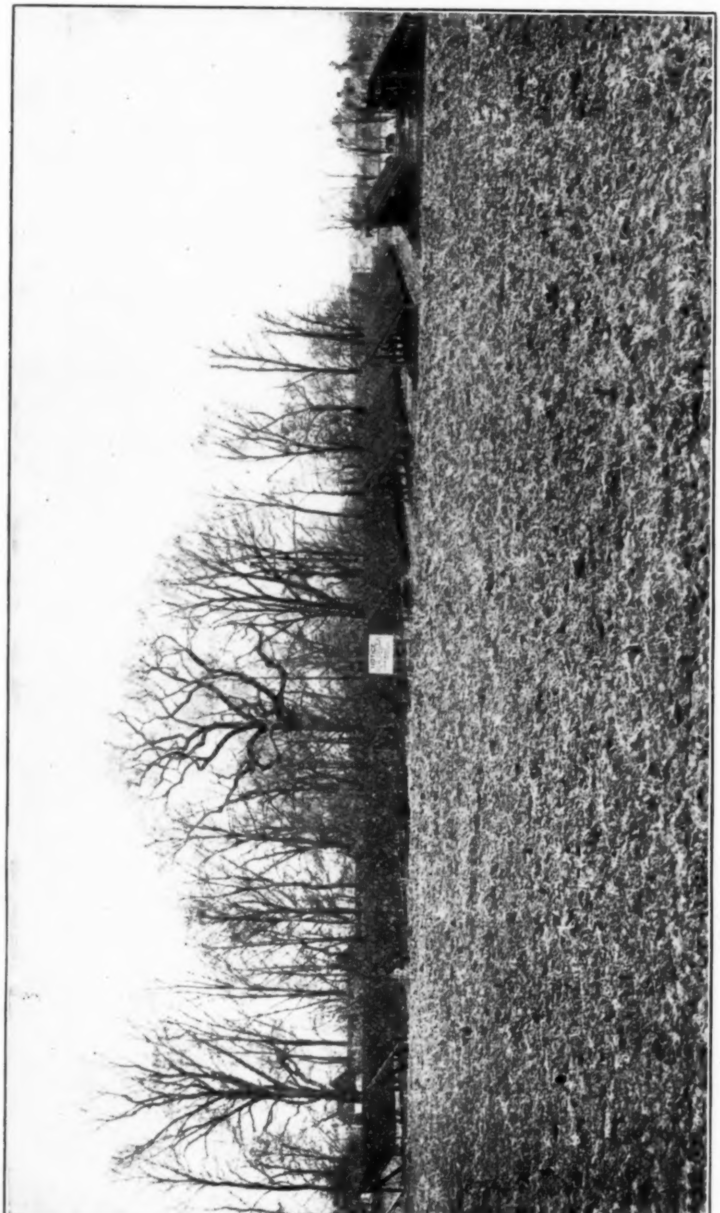


FIG. 7.—Annapolis Test Rack. Sheets exposed October 17, 1916. Photographed April 23, 1918.

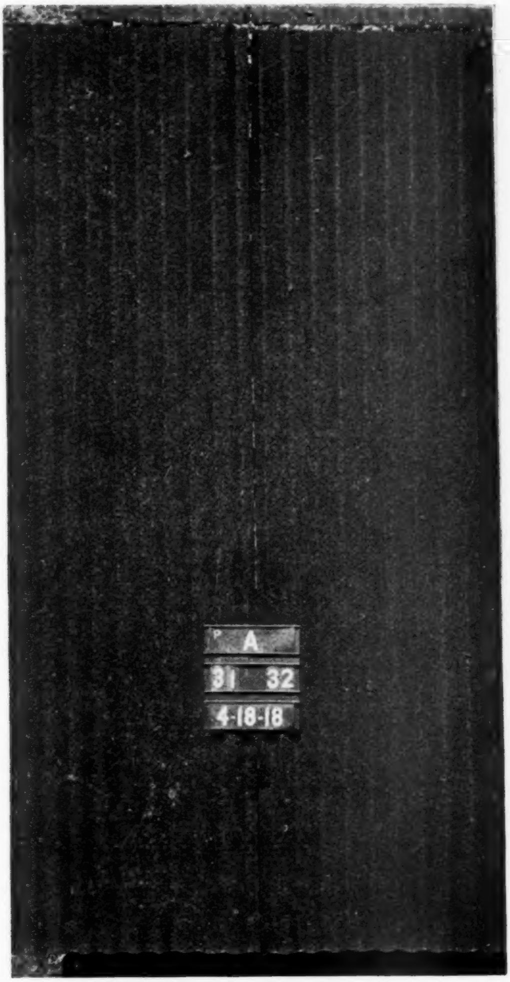


FIG. 8.—PITTSBURGH TESTS.

NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 31.......	0.04	0.35	0.078	0.036	....	0.006	....
A 32.......	0.04	0.36	0.105	0.046	....	0.008	....

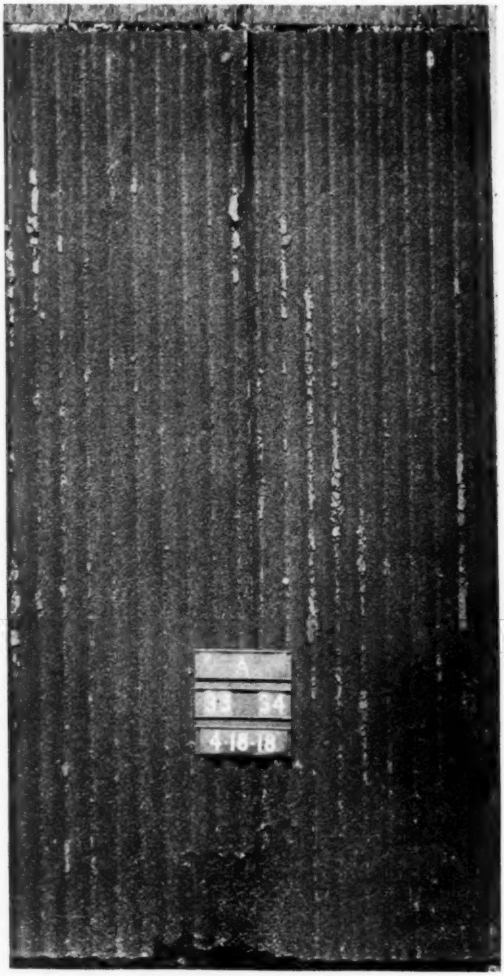


FIG. 9.—PITTSBURGH TESTS.

NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 33.......	0.04	0.36	0.086	0.035	....	0.008	....
A 34.......	0.04	0.38	0.084	0.039	....	0 008	....

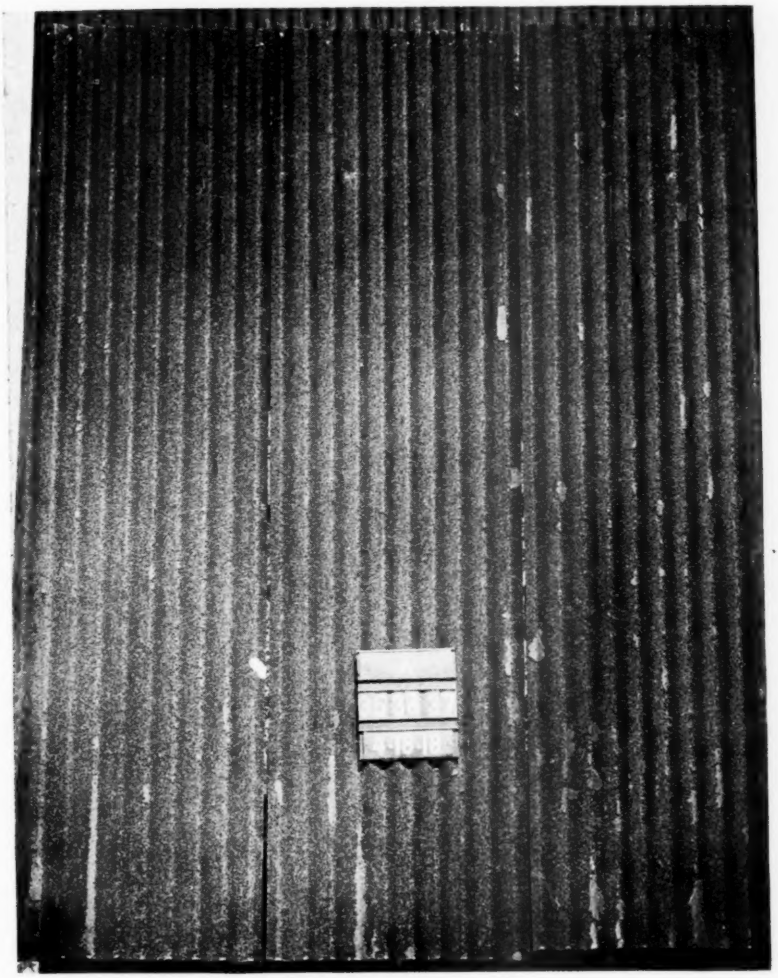


FIG. 10.—PITTSBURGH TESTS.

NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 35.......	0.04	0.36	0.090	0.036	0.012	0.006	0.002
A 36.......	0.03	0.37	0.093	0.042	....	0.008	....
A 37.......	0.04	0.40	0.087	0.035	....	0.008	....

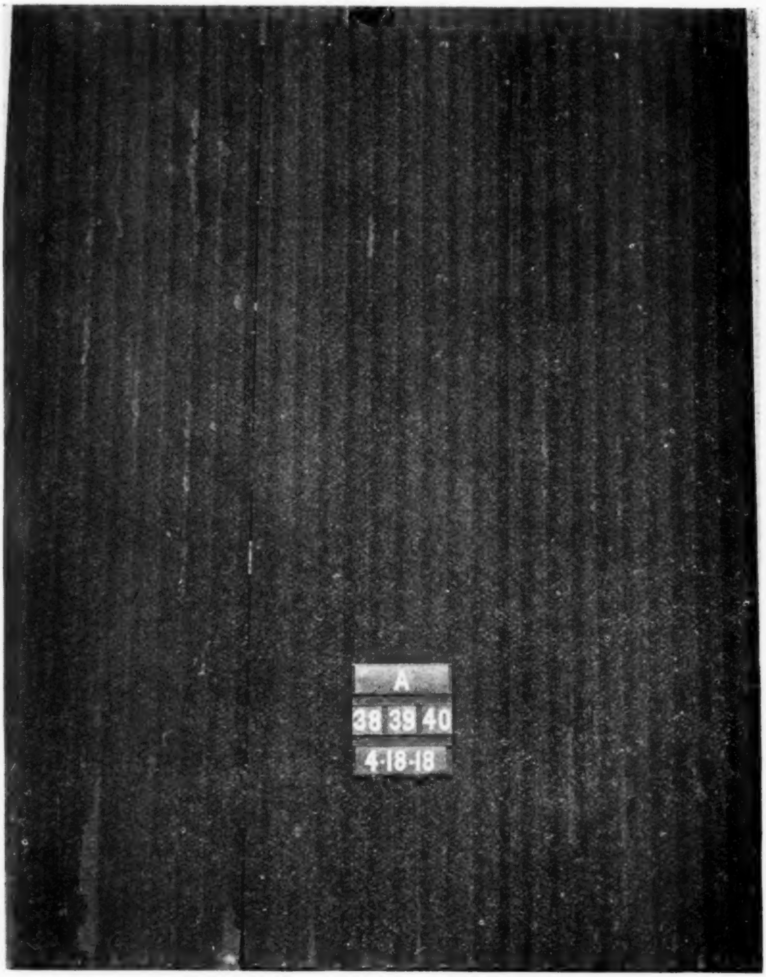


FIG. 11.—PITTSBURGH TESTS.
NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 38.......	0.02	0.37	0.091	0.040	....	0.014	....
A 39.......	0.03	0.37	0.094	0.037	....	0.006	....
A 40.......	0.04	0.39	0.092	0.039	0.014	0.006	0.003

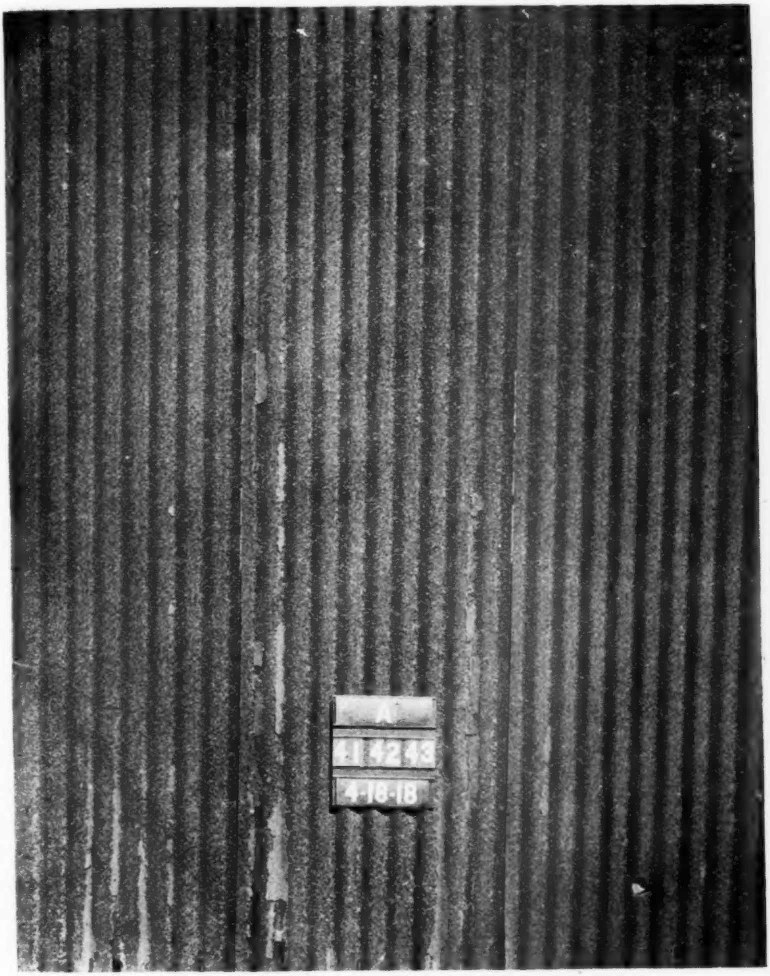


FIG. 12.—PITTSBURGH TESTS.

NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 41.......	0.047	0.41	0.088	0.041	0.005	0.012	....
A 42.......	0.040	0.41	0.089	0.041	0.004	0.014	....
A 43.......	0.036	0.38	0.095	0.047	0.005	0.014	....

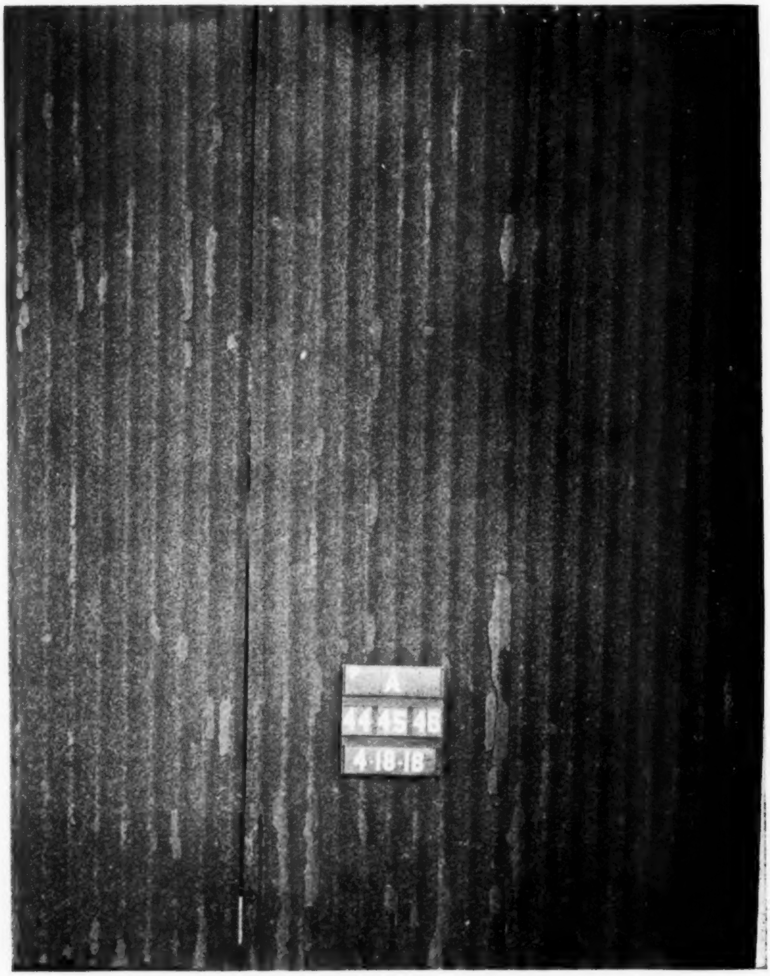


FIG. 13.—PITTSBURGH TESTS.
NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 44.......	0.037	0.36	0.090	0.040	0.004	0.016	....
A 45.......	0.026	0.38	0.094	0.044	0.005	0.014	....
A 46.......	0.041	0.41	0.082	0.040	0.004	0.014	....

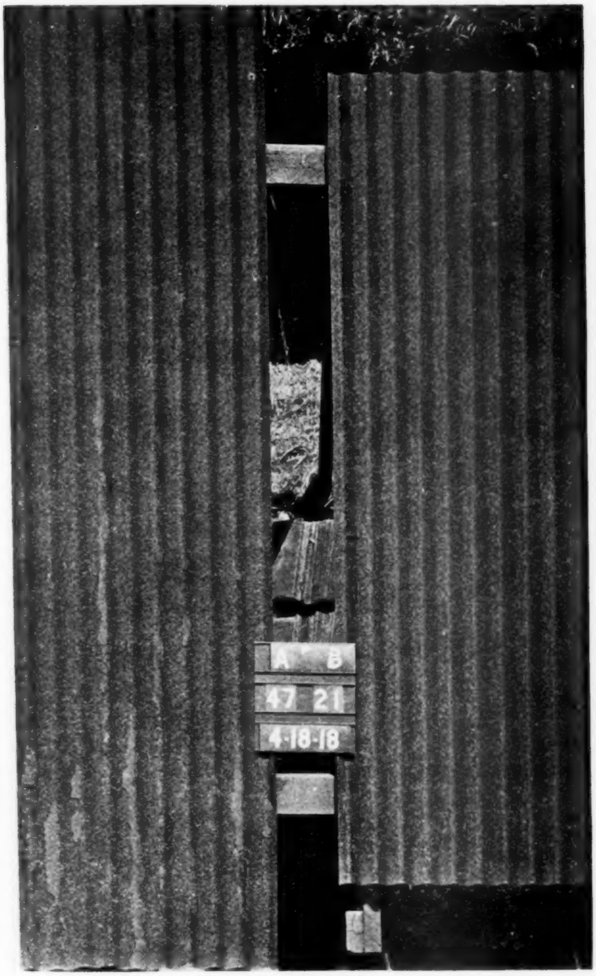


FIG. 14.—PITTSBURGH TESTS.

NO. 22 GAGE BESSEMER STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
A 47.......	0.034	0.39	0.083	0.041	0.005	0.010	....

NO. 22 GAGE OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
B 21.......	0.07	0.22	0.009	0.047	0.003	0.173	....

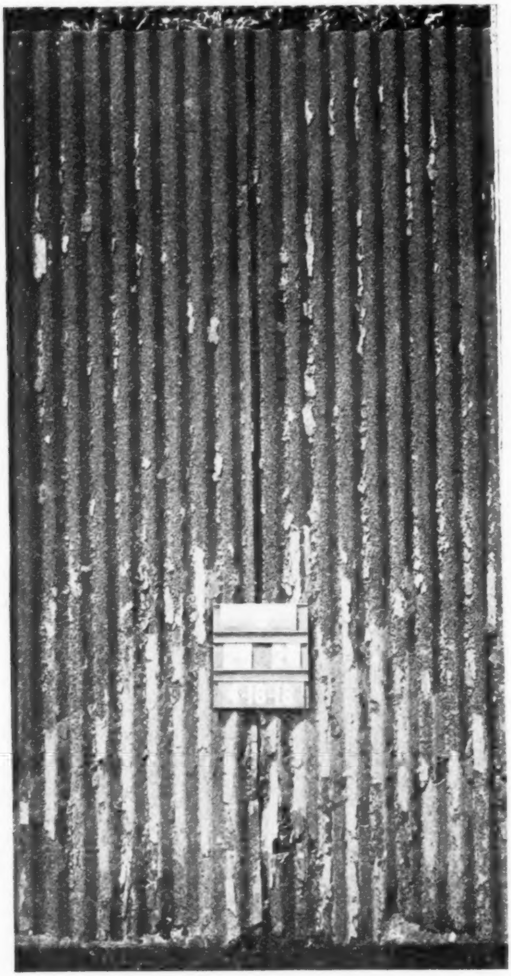


FIG. 15.—PITTSBURGH TESTS.

No. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
O 25.......	0.109	0.57	0.011	0.034	0.236	0.029	....
O 26.......	0.11	0.57	0.010	0.032	0.236	0.030	....

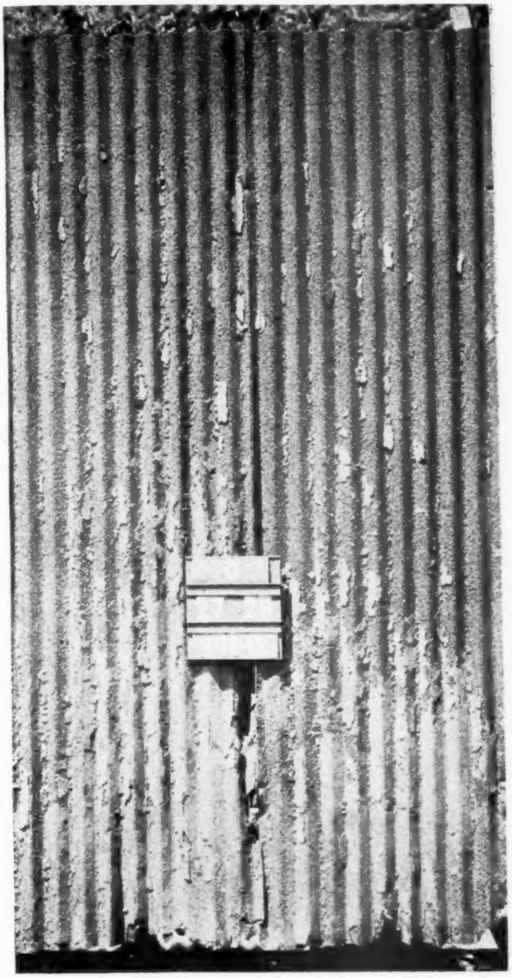


FIG. 16.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
O 27.......	0.11	0.57	0.010	0.033	0.448	0.030	....
O 28.......	0.15	0.54	0.012	0.027	0.22	0.016	trace

FIG. 17.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
O 29.......	0.15	0.54	0.007	0.027	0.22	0.024	trace
O 30.......	0.15	0.54	0.006	0.027	0.22	0.024	trace
O 31.......	0.13	0.55	0.007	0.026	0.21	0.016	trace

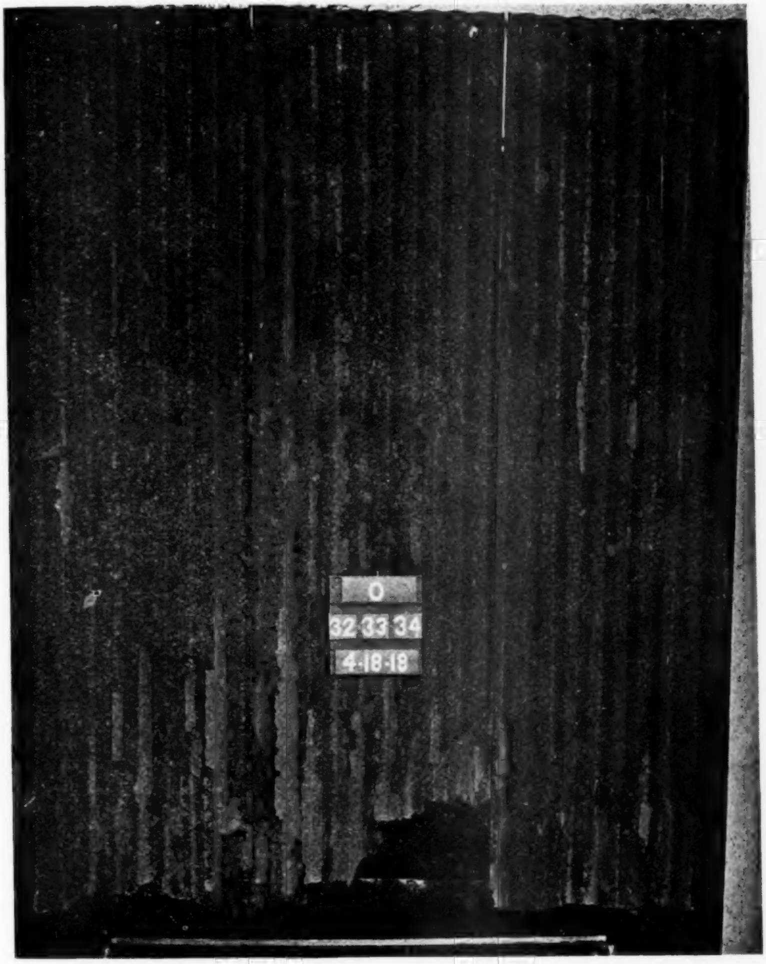


FIG. 18.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
O 32.......	0.15	0.55	0.006	0.027	0.23	0.016	trace
O 33.......	0.14	0.54	0.006	0.027	0.23	0.012	trace
O 34.......	0.13	0.54	0.008	0.028	0.20	0.016	trace

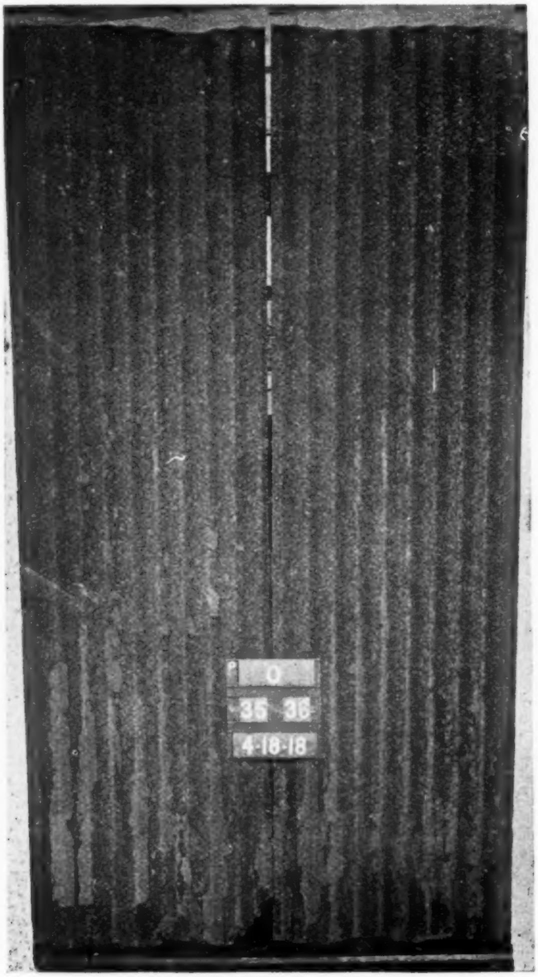


FIG. 19.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
O 35.......	0.14	0.55	0.007	0.028	0.22	0.012	trace
O 36.......	0.14	0.55	0.007	0.027	0.20	0.012	trace

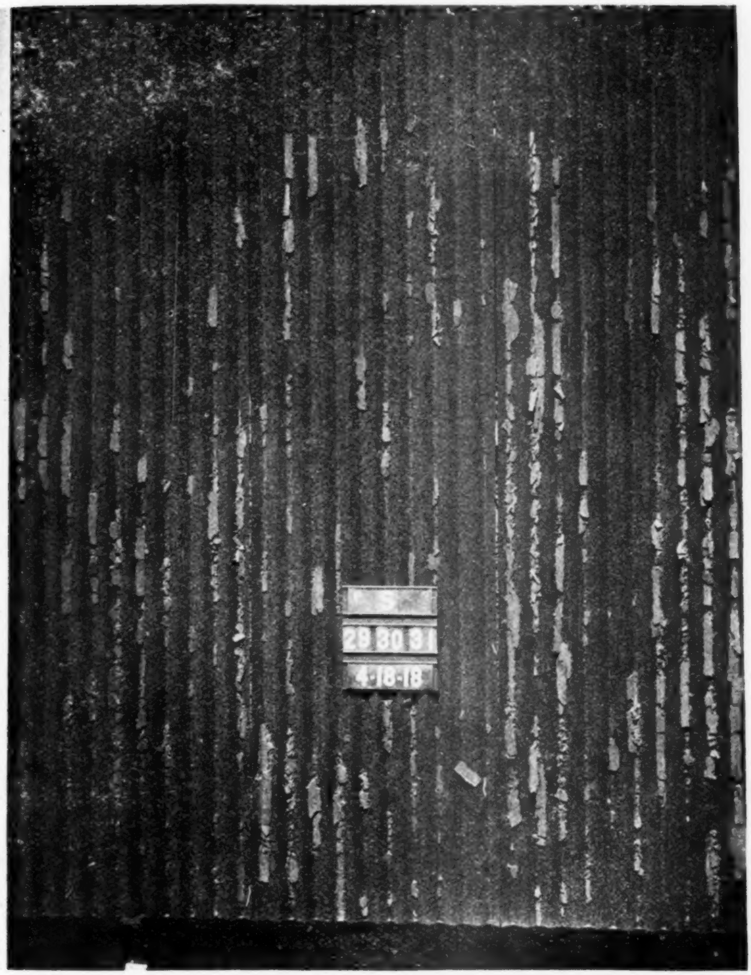


FIG. 20.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
S 29.......	0.018	0.013	0.005	0.019	....	0.021	trace
S 30.......	0.02	0.011	0.005	0.018	....	0.026	trace
S 31.......	0.019	0.012	0.005	0.018	....	0.030	trace

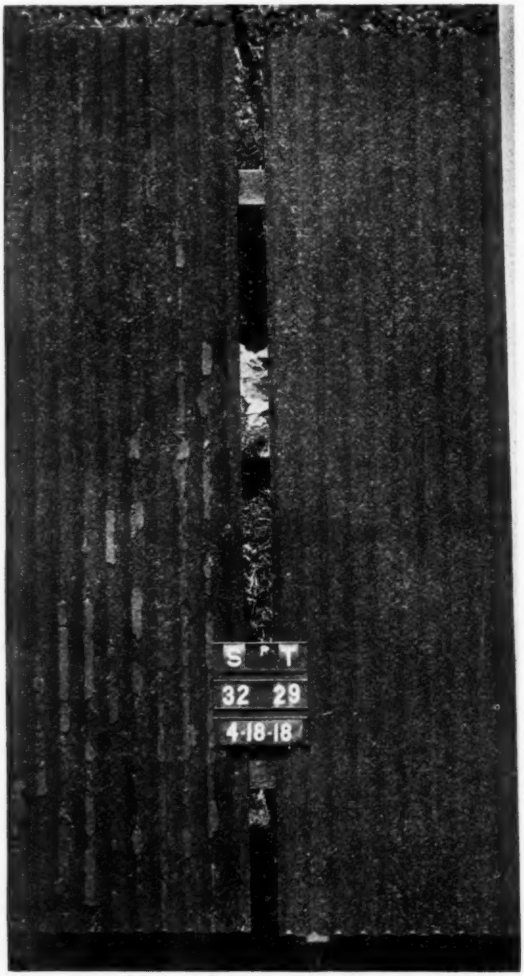


FIG. 21.—PITTSBURGH TESTS.

No. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.
"Armco"—American Rolling Mill Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
S 32.......	0.02	0.018	0.005	0.029	0.001	0.016	none

No. 22 GAGE COPPER-BEARING STEEL—SERIES B.
"Kentucky"—Newport Rolling Mill Co.

T 29.......	0.085	0.294	0.007	0.018	0.009	0.216	none

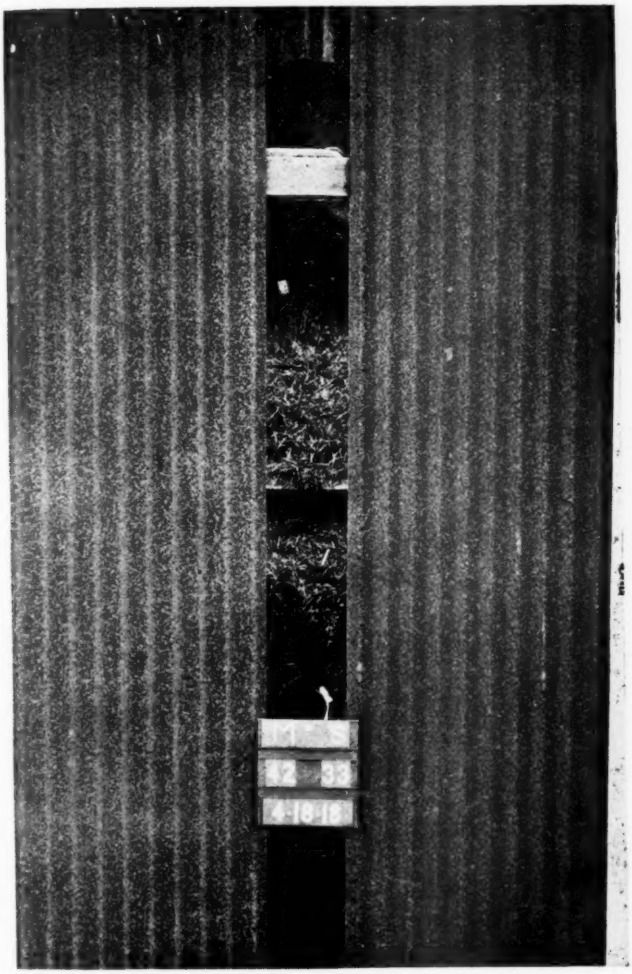


FIG. 22.—PITTSBURGH TESTS.

NO. 22 GAGE COPPER-BEARING OPEN-HEARTH STEEL—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
M 42.......	0.085	0.42	0.015	0.040	0.006	0.20	none

NO. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.
"Armco"—American Rolling Mill Co.

S 33.......	0.02	0.018	0.003	0.028	....	0.01	none

FIG. 23.—PITTSBURGH TESTS.
NO. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.
"Armco"—American Rolling Mill Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
S 34.......	0.02	0.018	0.004	0.028	....	0.01	none
S 35.......	0.02	0.018	0.003	0.024	0.001	0.006	none
S 36.......	0.015	0.02	0.006	0.022	0.005	0.03	none

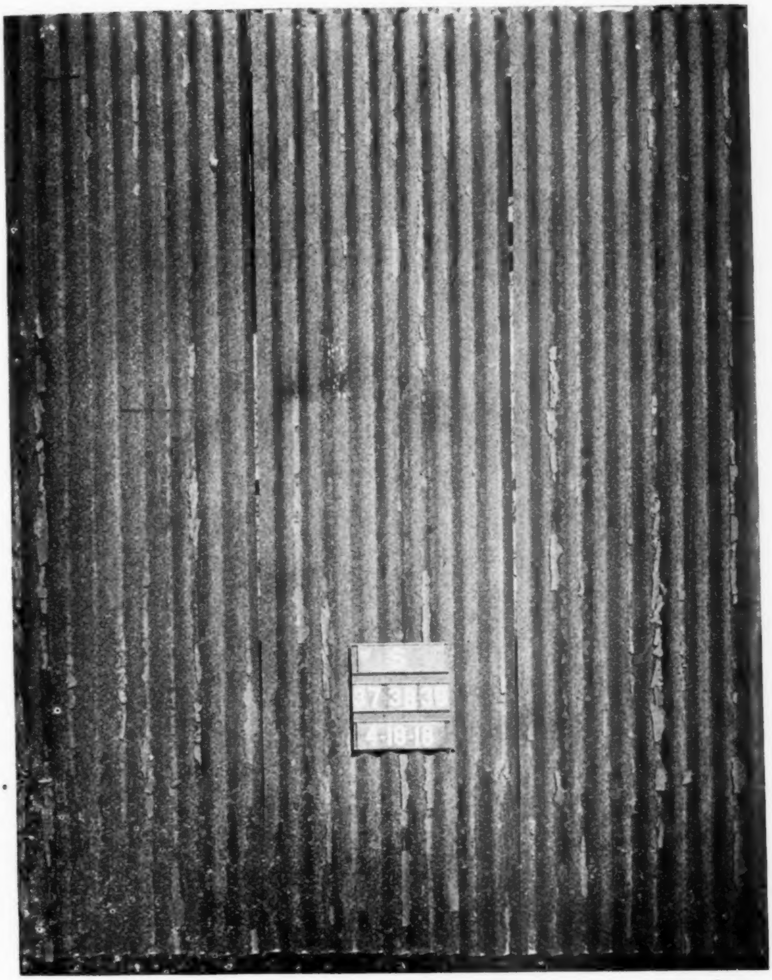


FIG. 24.—PITTSBURGH TESTS.

NO. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.

"Armco"—American Rolling Mill Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
S 37.......	0.015	0.02	0.004	0.027	0.006	0.024	none
S 38.......	0.025	0.02	0.006	0.029	0.005	0.03	none
S 39.......	0.015	0.02	0.005	0.027	0.005	0.024	none

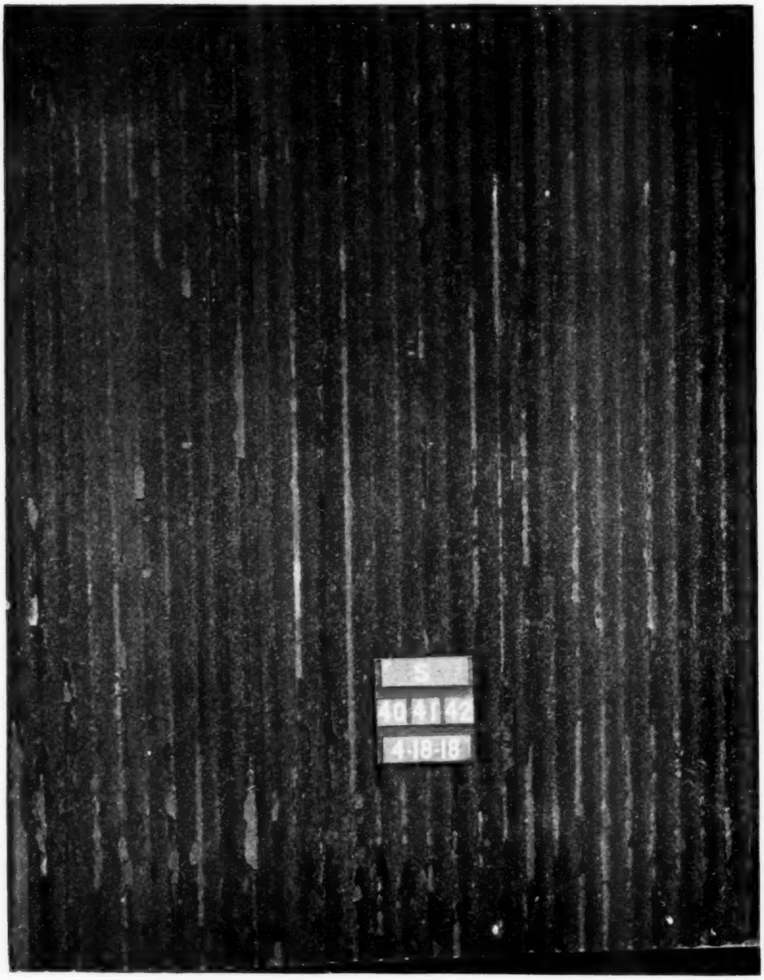


FIG. 25.—PITTSBURGH TESTS.
No. 22 GAGE LOW-COPPER OPEN-HEARTH IRON—SERIES B.
"Armco"—American Rolling Mill Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
S 40.......	0.01	0.02	0.004	0.029	0.005	0.04	none
S 41.......	0.01	0.02	0.005	0.030	0.004	0.03	none
S 42.......	0.02	0.02	0.006	0.026	trace	0.03	none

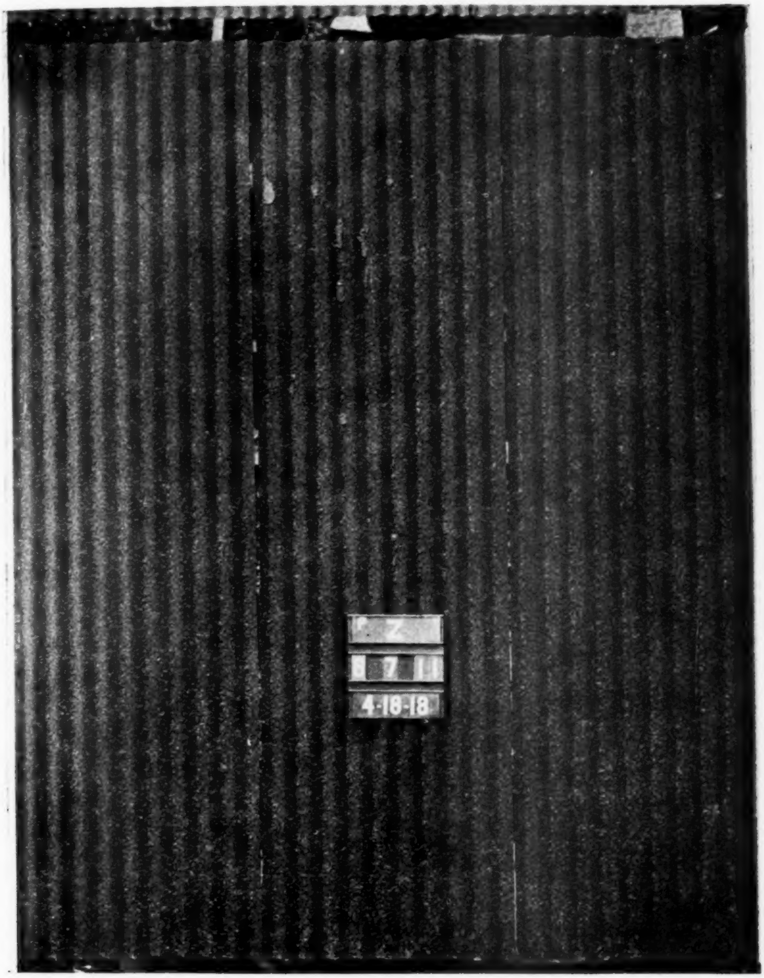


FIG. 26.—PITTSBURGH TESTS.
NO. 22 GAGE BESSEMER STEEL (VARYING COPPER CONTENT)—SERIES B.
Youngstown Sheet and Tube Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Z 6........	0.045	0.35	0.128	0.045	0.003	0.023	none
Z 7........	0.065	0.35	0.112	0.047	....	0.022	none
Z 11.......	0.055	0.40	0.116	0.052	....	0.016	none

FIG. 27.—PITTSBURGH TESTS.

NO. 16 GAGE BESSEMER STEEL (SAND BLASTED)—SERIES A.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
AA 50.....	0.08	0.42	0.093	0.046	....	0.006	....
AA 51.....	0.07	0.44	0.085	0.041	0.009	0.008	0.002
AA 52......	0.05	0.44	0.086	0.041	....	0.012	....

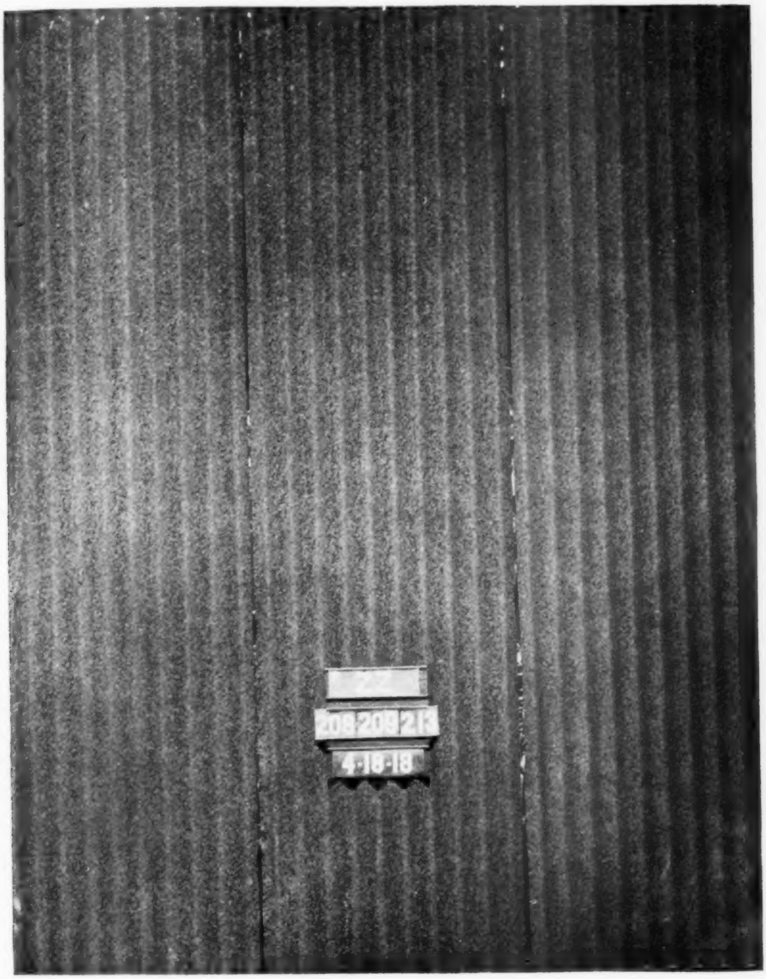


FIG. 28.—PITTSBURGH TESTS.
NO. 16 GAGE BESSEMER STEEL (VARYING COPPER CONTENT)—SERIES B.
Youngstown Sheet and Tube Co.

SHEET.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
ZZ 208.....	0.10	0.31	0.101	0.060	....	0.20	none
ZZ 209.....	0.085	0.30	0.087	0.045	none	0.23	none
ZZ 213.....	0.08	0.31	0.077	0.035	none	0.30	none

APPENDIX III.

STRUCTURE OF COMMERCIAL ZINC COATINGS.

By Henry S. Rawdon.[1]

(Constituting the Report of Sub-Committee II, of Committee A-5, on Preservative Metallic Coatings for Metals.)

I. Introduction.

In the general study of the properties of protective metallic coatings there should be included early in the program a description of the microstructure of such coatings. The discussion of the structural features should be made not alone from the theoretical viewpoint but also should include a description of such variations as are likely to occur in the commercial product as it is usually put out. Some of the reasons for such a study are: to properly interpret the results obtained in the testing of such coatings (stripping tests, etc.), and to explain and predict the probable comparative service-behavior of different classes of coatings. In some coatings[2] certain of the microstructural constituents may actually accelerate the attack of the metal which the coating is aimed to protect and the technical literature contains various misleading statements[3] which suggest that a similar condition might exist in certain classes of zinc coatings.

The literature on the general subject of zinc or "galvanized" coatings is very voluminous; considerable work has also been done to determine the constitutional diagram of the alloys of zinc and iron.[4] The number of articles, however, describing

[1] Secretary, Sub-Committee II of Committee A-5.

[2] Bureau of Standards, *Technologic Paper No. 90;* Structure of the Coating on Tinned Sheet Copper in Relation to a Specific Case of Corrosion.

[3] See, for example, Wm. Guertler, Metallographie, Vol. I, p. 439.

[4] The latest and most reliable on this phase of the subject is Raydt and Tammann, The Structure and Properties of Zinc-Iron Alloys melted under Pressure. Zeit. anorg. Chemie, Vol. 83, p. 257.

the structure of zinc coatings as they are actually produced is very limited.[1]

II. TYPES OF COATINGS EXAMINED.

At present, the number of types of zinc coatings in common commercial usage is four. By far the most widely used and best known is the material coated by "hot-dipping" in a bath of molten zinc; the other methods in use for producing coatings of zinc are "sherardizing," electrodeposition, and, to a limited extent, the Schoop or spray process. The specimens illustrative of each of these four types which were examined are listed below:

The hot-dipped sheets[2] included samples illustrative of light, medium, and heavy weight coatings; samples re-run four times through the bath, and samples held in the bath approximately eight times as long as what is considered good practice.

The sherardized materials included light, medium, and extra heavy coatings.

The sprayed materials were designated by the manufacturers as one, two, three and four sprays.

For electrogalvanized material, a great many specimens with coatings varying from extremely thin to extra heavy grade were examined.

III. THEORETICAL MICROSTRUCTURE OF ZINC COATINGS.

In at least two of the four types, the coating is far from being a simple layer of zinc superimposed upon the base metal beneath, but is a rather complex layer, composed of alloys of iron and zinc of various compositions. In order to understand properly the formation of these alloys and their composition, and for puposes of reference, the constitutional diagram of the iron-zinc alloys as modified by Raydt and Tammann[3] is given in Fig. 1.

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[1] The best of these are:—

Wm. Guertler, Structure of Galvanized Irons, Zeit. int. Metallographie, Vol. 1, p. 353.

W. Arthur and W. H. Walker, Structure of Galvanized Iron; Am. Inst. of Metals, Vol. VI, p. 82.

H. Arnold, The Structure of Metallic Coatings Prepared by the Metallic Spraying Method; Z. anorg. Allgem. Chem., Vol. 99, p. 67.

[2] The hot-dipped and sherardized materials were specially prepared by members of Committee A-5 engaged in manufacturing material of this kind, the remainder was from several firms engaged exculsively in these particular lines of the industry.

[3] *Loc. cit.*

Alloys with an iron content of more than 25 atomic per cent (22 per cent by weight) are formed only with difficulty, usually by melting the constituents under pressure. Hence a structure

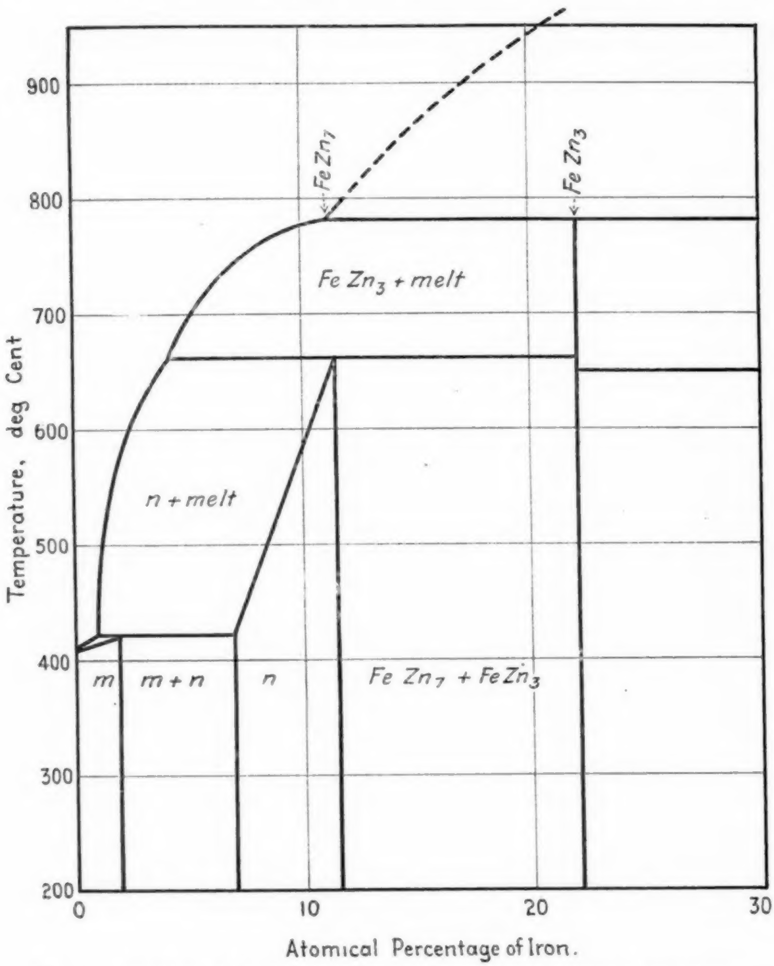
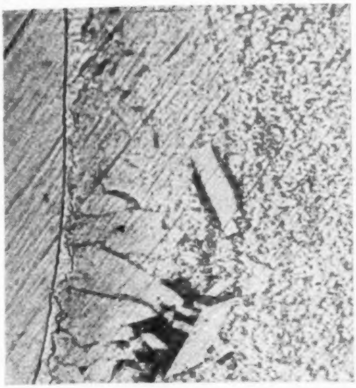
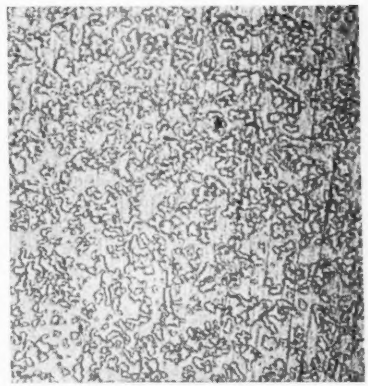


FIG. 1.—Portion of the Constitutional Diagram of the Zinc-Iron Alloys.

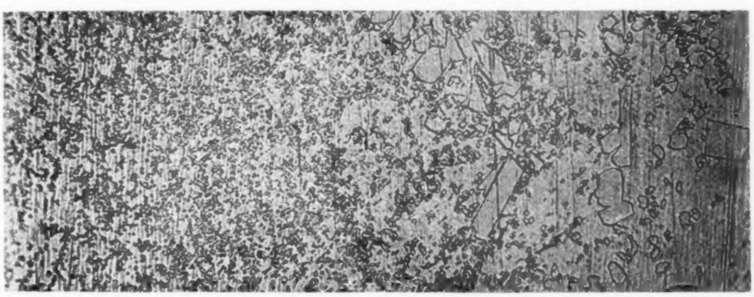
corresponding to an iron content beyond this value may be disregarded in the discussion of zinc coatings. The constitutional diagram shows four structural fields or layers which are possible



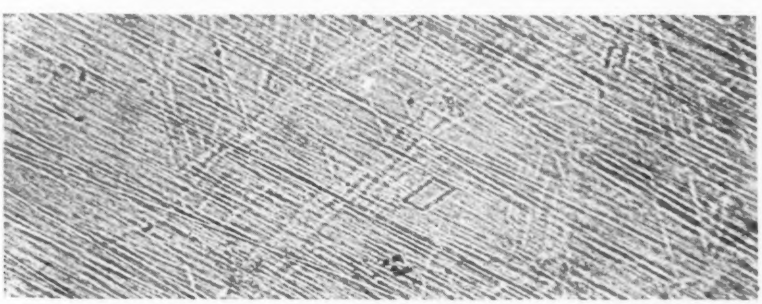
(*a*) Layer *A* of the compound $FeZn_3$ adjacent to the wire; alloy layer *B* of $FeZn_7$ and perhaps some $FeZn_3$. (×500).



(*b*) Duplex layer *C* of particles of $FeZn_7$ embedded in a soft matrix of zinc containing some iron in solution. (×500).



(*c*) Outer edge of layer *C* showing some large, well-formed crystals. (×200).



(*d*) Outer layer of zinc (containing some iron in solution). The shadow-like etch markings are rather characteristic of zinc. (×200).

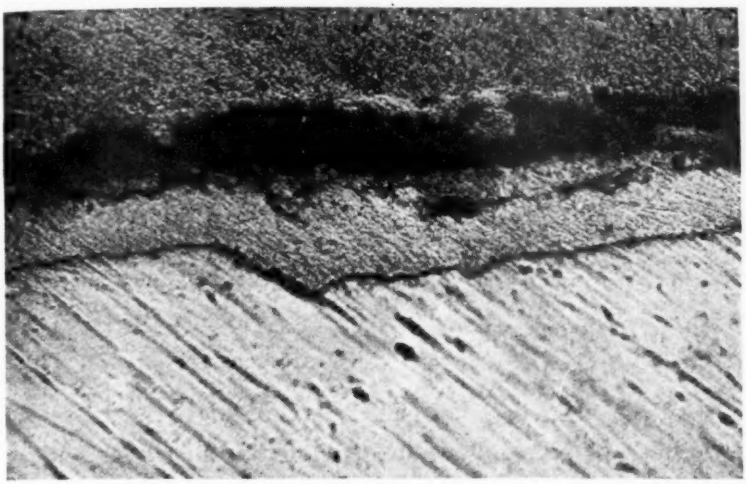
FIG. 2.—Microstructure of Zinc Coating, Formed on an Iron Wire, Immersed in Molten Zinc for 4 Hours. Etching: 1 per cent iodine in alcohol was used for etching throughout, and for remaining samples, unless stated otherwise.

in a coating which is allowed to come to equilibrium with the iron base. These are (1) an outer one (*m*) of zinc containing a small percentage of iron in solid solution (about 0.7 per cent); (2) a duplex one ($m + n$) composed of a matrix similar to (1) in which are embedded particles of *n* (a solid solution of a chemical compound, $FeZn_7$, with some zinc); (3) a layer composed entirely of the solid solution *n;* and (4) a duplex layer of two definite chemical compounds, $FeZn_7$ and $FeZn_3$, the amount of each compound varying in this field from pure $FeZn_7$ on one side to $FeZn_3$ on the other.

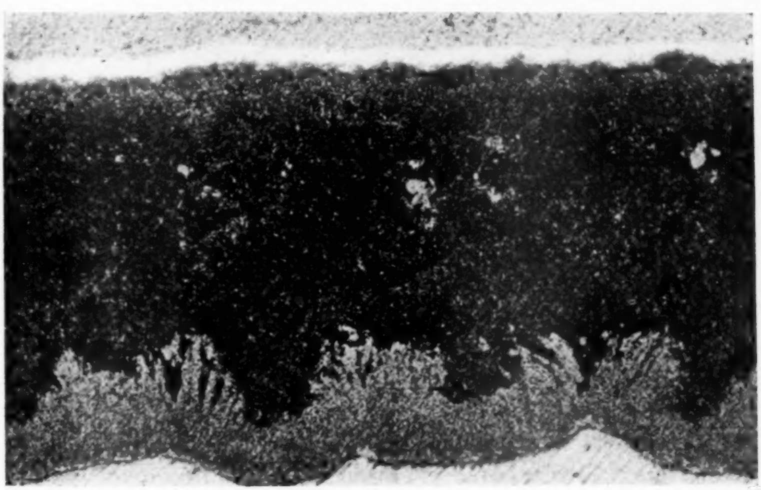
A zinc coating showing the various layers corresponding to the different fields of the structural diagram was prepared by inserting a No. 16 B. & S. gage iron wire through a block of zinc about $\frac{3}{8}$ in. square in section and heating this for 4 hours slightly above the melting point of zinc (approximately 450° C). Iron from the wire permeates throughout the zinc block, so the resulting coating includes practically the entire block; it shows the following distinct layers as illustrated in Fig. 2. Adjacent to the iron is a thin layer, *A*, of the intermetallic compound $FeZn_3$; just outside of this, a much thicker layer, *B*, in which the definite form of the crystals is plainly seen (this probably contains both $FeZn_3$ and $FeZn_7$); a very thick layer, *C*, consisting of tiny crystals of the compound $FeZn_7$ in a softer matrix comprises, by far, the greater part of the coating; the crystals in the outer margin of this layer are particularly well formed and much larger than the average throughout the layer. The outermost portion, *D*, of the coating shows the characteristic etch-markings of "pure" zinc, probably of the nature of Neumann lines; the metal here shows only a few traces of the second constituent; it undoubtedly contains iron, in solid solution, up to its saturation point (0.7 per cent). The nature of the various layers and their behavior during corrosion is discussed below (Section V).

IV. VARIATIONS IN MICROSTRUCTURE OF COMMERCIAL COATINGS.

1. *Hot-Dipped Material.*—The variations in structure of this type of coating which may arise in practice are best shown by comparison with the structure when equilibrium is reached, as described above. In general, the same layers were formed in



(*a*) Thin coating; average weight of coating as determined by weighing the sheet before and after dipping, 1.37 oz. per sq. ft.

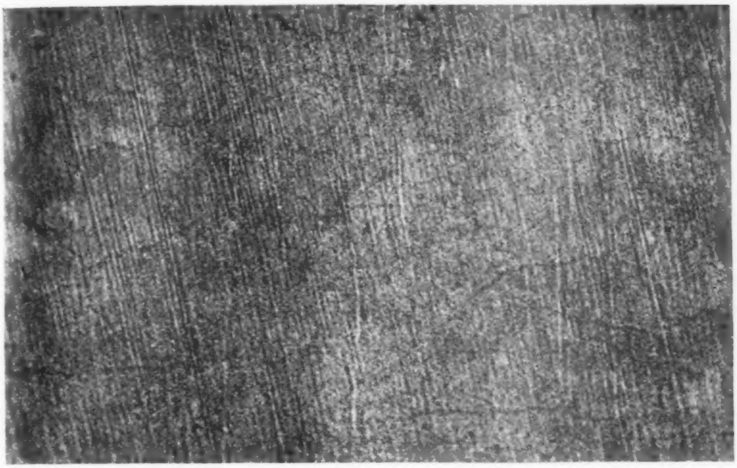


(*b*) Thick coating; average weight, 2.5 oz. per sq. ft. The same constituents are shown as in Fig. 2.

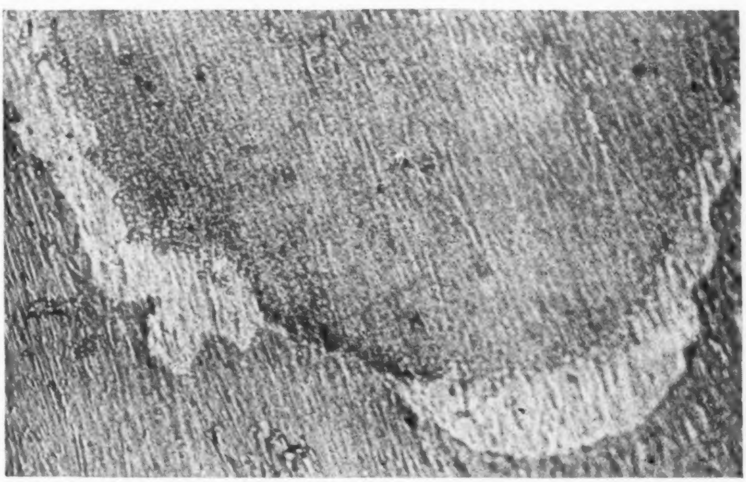
FIG. 3.—Commercial Hot-Dipped Zinc Coatings (×500).

each specimen of this type examined; the relative amount of each constituent, however, varies considerably according to the conditions of dipping. Fig. 3 (*a*)[1] shows the structure of one of the thinnest of the coatings of this type examined (galvanized sheet, described by the manufacturers as having 1.37 oz. zinc per sq. ft., both surfaces). An extremely thin innermost layer of $FeZn_3$ is to be seen of approximately the same thickness as in the heavy coating, Fig. 3 (*b*), which contains 2.5 oz. of zinc. Inasmuch as the total thickness of the coating is controlled by mechanically adjusting the height of the molten bath relative to the guiding rollers and not by increasing the period of immersion in the zinc, it is to be expected that such would be the case. By holding the article to be plated for a much longer period in the zinc bath, this inner layer is given a chance to increase considerably in thickness, as is shown in Fig. 5 (*a*) and (*b*), which represents a sample held for approximately eight times as long in the bath as is considered good commercial practice, and also a sample which was run through the bath several times in succession. The intermediate alloy layer appears to be of approximately the same thickness in both the thinly and thickly coated commercial sheets, the difference in the weight of the coating being due to an increase of the outer zinc-rich layers in the thicker coating. (The removal of the excess outer zinc-rich layers in the thin coatings does not allow the crystals of the intermediate alloy layer to form as perfectly as is the case in thick coatings.) By increasing the time the molten zinc is in contact with iron base, the relative thickness of the inner alloy layers is increased; this will be accompanied by a corresponding decrease of the outer zinc-rich layers, particularly in the coatings of sheets, wires, etc., in which the thickness is kept fairly uniform by some mechanical means. The significance of these alloy layers in service behavior is indicated below (Section V). The sheets which were held for a considerable length of time in the molten zinc were found, after standing about two weeks, to be spotted with numerous exudations. See Fig. 6 (*b*). There is nothing in the microstructure to account for this other than some tiny pockets which apparently were filled with inclusions

[1] All micrographs are arranged so that the steel base is at the lower side of the figure, that is, toward the bottom of the page. On those micrographs in which a whole cross-section of the coating is shown, the granular portion at the top of the figure is the layer of electrolytic copper deposited upon the zinc to protect it during the process of polishing.



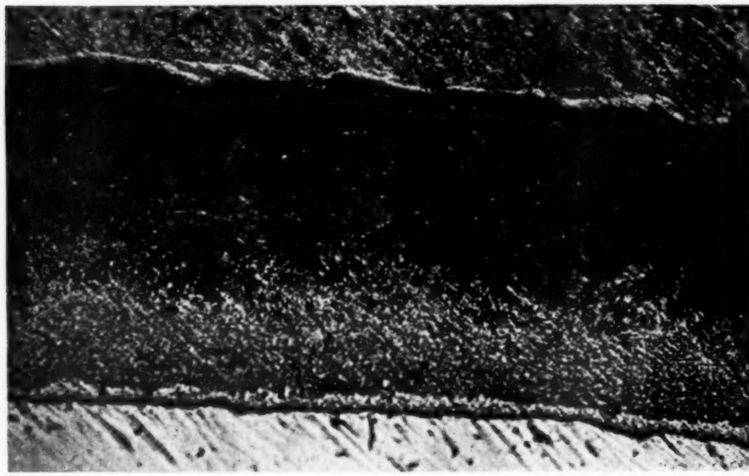
(*a*)



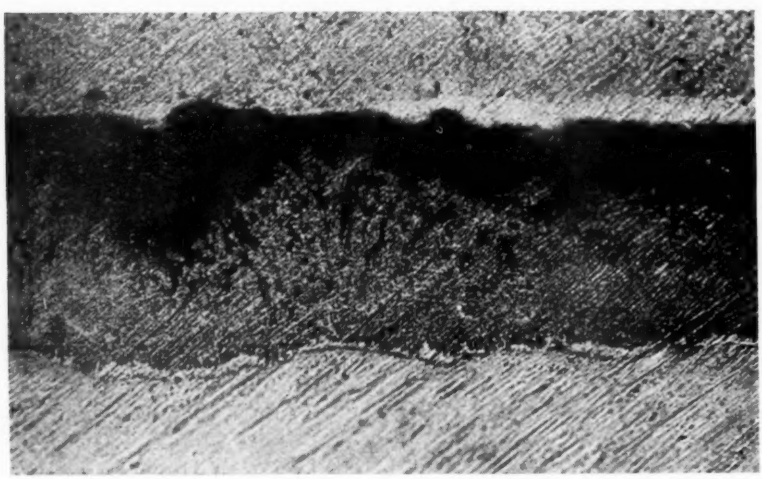
(*b*)

FIG. 4.—Commercial Hot-Dipped Zinc Coated Sheets (×500).

Oblique section of material of (*b*) Fig. 3, showing the inner layers: (*a*) shows a fine network of cracks in the alloy layer; (*b*) shows the innermost or marginal layer of $FeZn_3$ (white).



(*a*) Material similar to that of Fig. 3 which was held stationary in the molten bath for two minutes.



(*b*) Material similar to (*a*), re-run through the molten bath four times.

FIG. 5.—Commercial Hot-Dipped Zinc Coated Sheets, Produced under Unusual Conditions (×500). The alloy layers have been much accentuated by these treatments.

(*a*) Usual appearance.

(*b*) Appearance of the material of Fig. 5 (*a*); upon standing the surface became covered with spots of flux which had exuded from within the coating.

FIG. 6.—Surface Appearance of Hot-Dipped Sheets.

of the zinc and ammonium-chloride flux from the bath which, under the influence of atmospheric moisture, swelled and exuded out of the coating. Whether such inclusions of the flux will materially affect the life in service of such coated sheets cannot be stated with certainty from a study of the structure alone. Most of the pits and inclusions, however, appear to be in the outer layers of the coating, and not between the coating and the base metal.

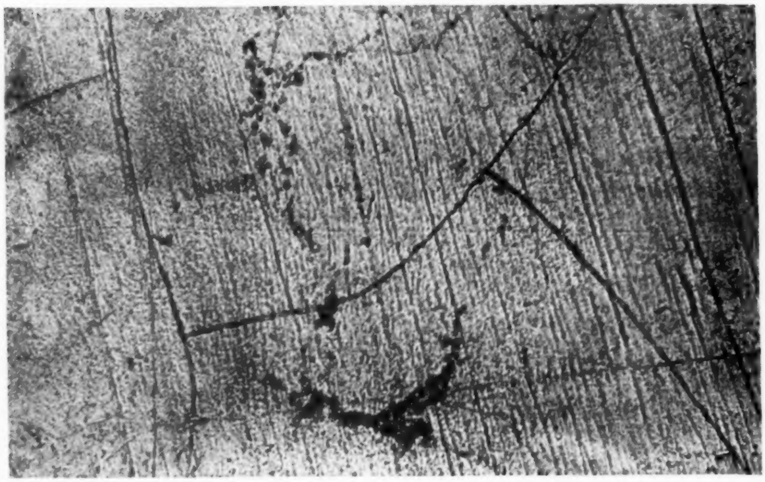
2. *Sherardized Coatings.*—In coatings of this type it is only in those of considerable thickness that any definiteness of structure appears. The materials examined had been very carefully prepared, and the average thickness of coating varied as follows in the different samples,—0.002, 0.004, 0.005, 0.007, and 0.008 in.[1] The last sample is given in Figs. 7 and 8 and shows the structural features which may be expected to occur in such coatings. The nature and composition of the zinc-dust mixture in which the articles are packed for heating probably determines almost entirely the nature of all but the innermost layers where alloying with the iron base occurs. The outer portions have a characteristic rough and porous appearance and contain considerable inclusions of oxide and any foreign ingredients which may be present in the heating mixture. The inner portions of this outer layer are much denser than those near the outer surface and have a very characteristic appearance, being broken up by many fine intersecting cracks, caused probably by contraction upon cooling. The inner layer, Fig. 8 (*b*), which easily etches dark, in all probability marks the outer limit of the alloying of the iron of the base with the zinc of the coating. An extremely thin layer immediately adjacent to the iron base, and apparently of the compound $FeZn_7$, marks the union of the coating with the base metal. In none of the coatings, except the two thickest ones, were these two innermost layers found; the coating in the others consisted entirely of what, in the thicker ones, constitutes the intermediate layer and the outer porous portion.

3. *Sprayed Coatings.*—The variations noted in this type of coatings are of a mechanical origin, due to the nature of the method of deposition, rather than to any alloying of the zinc

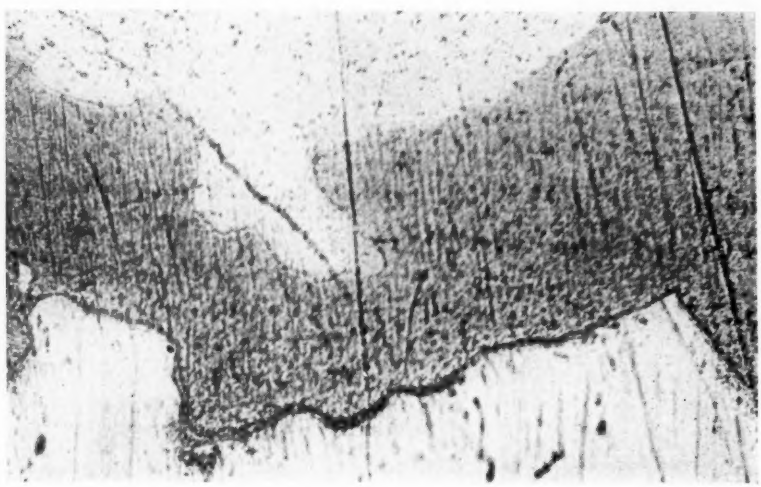
[1] The thickness of the coating was estimated by the manufacturer from the temperature of the furnace and time of heating and not from any stripping tests.

FIG. 7.—Structure of Sherardized Coating; Oblique Section of a Coating Averaging 0.008 in. in Thickness ($\times 100$).

A.—Decarburized surface of the steel plate.
B.—Inner layer of coating.
C.—Intermediate fissured layer of the coating.
D.—Roughened outer surface.

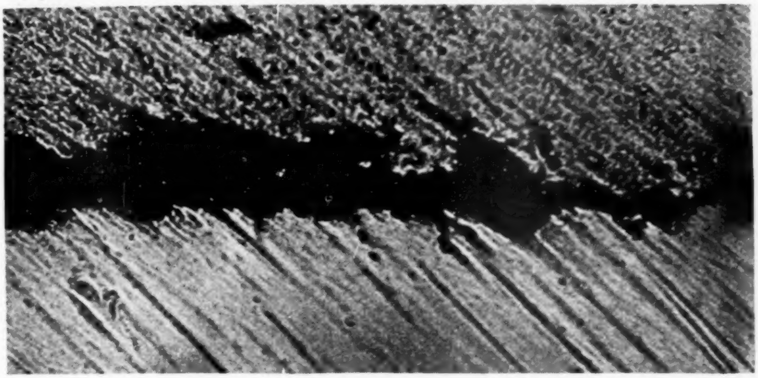


(*a*) Section of intermediate layer of the coating, showing the network of fine cracks and some of the inclusions retained from the heating mixture.



(*b*) Inner layer, which probably represents the extent of the outward alloying action of the iron; a very thin film of the compound, presumably $FeZn_7$, lies immediately adjacent to the iron base.

FIG. 8.—Sherardized Material (×500).



(*a*) "One spray" coat. The coating, which is very thin and irregular, has been etched dark.

(*b*) "Four spray" coat.

FIG. 9.—Cross-sections of "Sprayed" Zinc Coating (×500).

with the iron base. In Fig. 9 are shown cross-sections of two sheets coated by this process. The coating designated as "one spray" is very irregular and extremely thin in spots. The second sample was described by the manufacturer as a "four spray" coat, but the structure suggests that a coating somewhat heavier than this was applied. The distinct lamellae which comprises the coat are due to the additional layers of zinc superimposed upon the earlier ones, with some accompanying oxide.

4. *Electrodeposited Zinc Coatings.*—As is to be expected from the nature of the process by which such coatings are

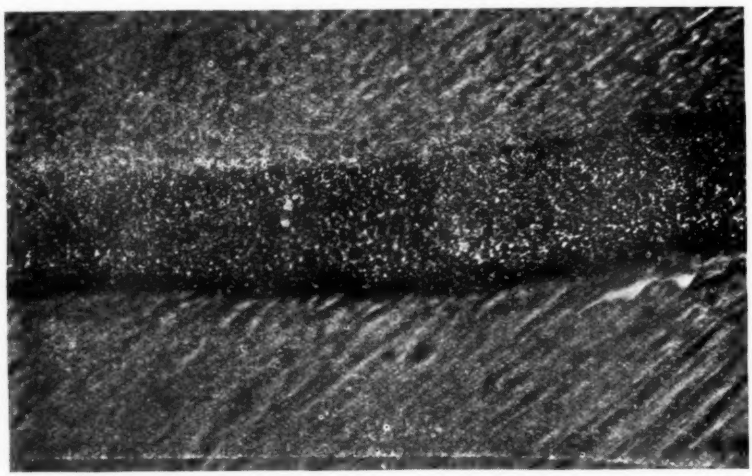


FIG. 10.—Cross-Section of Electrolytic Zinc Coating, deeply Etched with 10 per cent Sodium Hydroxide (×500).

deposited, they are essentially of pure zinc and show none of the different alloy layers seen in the first two types. Fig. 10 shows a coating of electrolytic zinc, deeply etched. No indications of structural variations across the section of the layer are to be seen. The principal point of interest in connection with the microstructure of this type is the variation in thickness which may exist on irregularly shaped pieces or even on flat surfaces. Such variations are to be found, particularly, in depressions and on sharp projections where the differences in the current density are considerable. This is especially true for the threaded portion of bolts and screws.

A set of measurements on two similar small machine bolts plated under identical conditions for different periods of time, gave the following results:

WEIGHT COATING COMPUTED FROM TANK CONDITIONS, OZ. PER SQ. FT.	AVERAGE THICKNESS, TOP OF THREAD, MM.	AVERAGE THICKNESS AT ROOT OF THREAD, MM.
0.2	0.0157	0.0038
0.55	0.0224	0.0053

Fig. 11 shows the variations in thickness of coating on a small article having several sharp corners.

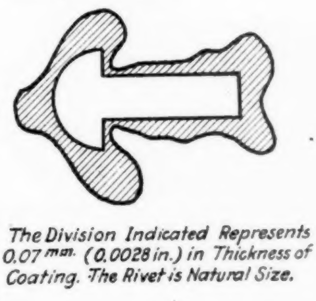


FIG. 11.—Variation in Thickness of the Zinc Coating (Electrolytic) on an Object having Sharp Angles.

Even on flat surfaces, the coating is not of uniform thickness. Fig. 12 shows a series of thickness measurements[1] made on a section of a plate, 4 in. square, which had been electroplated under very carefully controlled commercial conditions. The sections were cut $\frac{1}{2}$ in. apart, the longer one being taken along a diagonal of the plate.

V. SIGNIFICANCE OF STRUCTURE OF COATINGS.

Metallic coatings may protect the metal which they cover in different ways. All coatings offer mechanical protection from moisture and other corroding agencies. Some metal coatings, also, by their greater solubility than the base metal protect the metal beneath from corrosion in a chemical way.

[1] These measurements from a series of thickness measurements on this type of coated material by M A. Grossman, Bureau of Standards

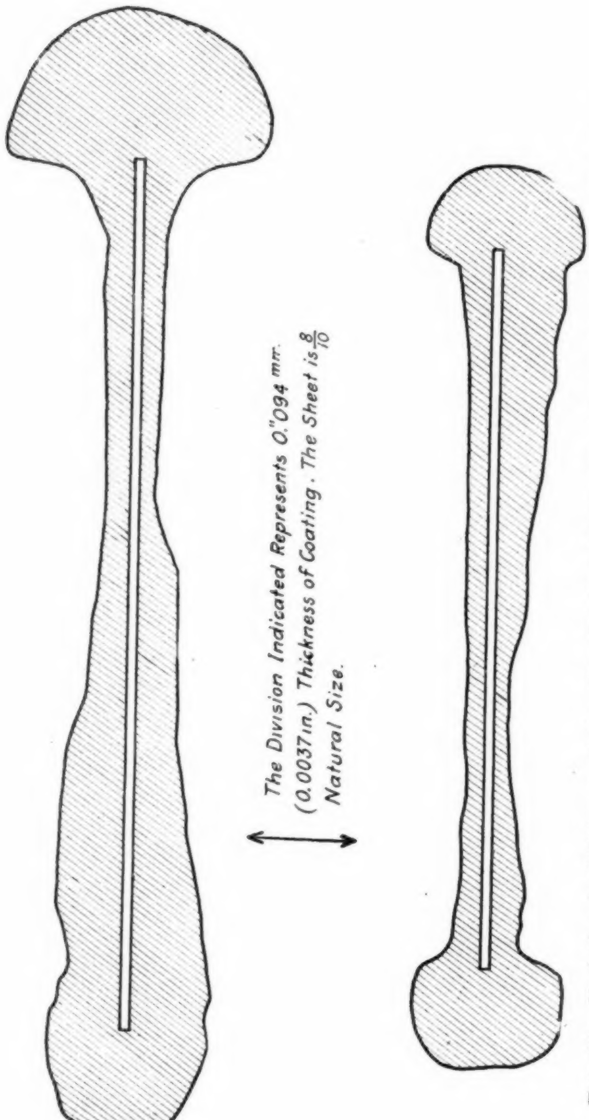


FIG. 12.—Variation in Thickness of the Zinc Coating (Electrolytic) which May Occur on Flat Sheets.

Of the common metals used for coatings, zinc is the only one which behaves in this manner. The significance of the various structures which may occur in different types of coatings should be considered with reference to the bearing they may have upon these two functions which the coating has to perform.

Various conflicting statements have appeared in the literature concerning the relative electrolytic electromotive forces of the different zinc-iron alloys, particularly those which occur in galvanized coatings. The behavior of the alloy layers upon

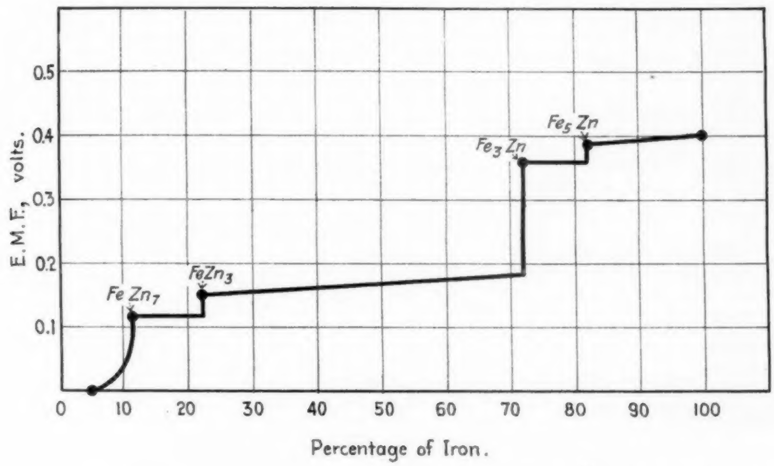


FIG. 13.—E.M.F. Measurements of the System Zn $- \frac{N}{20}$ $ZnSO_4$ – FeZn Alloys.

etching indicates that they are electro negative toward the zinc, that is, they bear the same general relation to zinc in this respect that iron does. Further than this cannot be stated with certainty. Guertler[1] states that the innermost layer ($FeZn_3$) is also more electro negative to the zinc than is iron and hence iron will be electro positive to such a layer; so that when both are exposed to corroding influences, by the wearing away of the outer layers, mechanical injury, etc., corrosion of the iron base will be accelerated by the inner layers. Others have apparently reiterated Guertler's statement, though some

[1] Wm. Guertler, Structure of Galvanized Irons, Zeit. int. Metallographie, Vol. I.

have later corrected such statements. Fig. 13 is constructed from the e. m. f. measurements of the system $Zn - \frac{N}{20} Zn\,SO_4 - FeZn$ Alloys[1] and shows that all of the alloys behave toward iron in the same general manner that pure zinc does, though not to the same degree. A short series of measurements of the relative e. m. f's. of the systems $Fe - \frac{N}{10} Fe\ Cl_3 - FeZn$ Alloys gave results of approximately the same relative magnitude as those shown in Fig. 13. In this case the alloys used were the outer layers of "hot-dipped" coatings, a very oblique section of the sample having been polished, covered with paraffin and the layer desired for testing having been exposed by pricking through the paraffin with a needle. No indication could be obtained suggesting that any of the layers are electro negative to iron.

Although both of the compounds, $FeZn_7$ and $FeZn_3$, are electro negative toward zinc, and so will aid somewhat in the solution of the zinc when either one is exposed to the corroding agency along with the zinc, it appears that such action may safely be disregarded. Fig. 14 shows a section of the coating on hot-dipped galvanized sheet on the exposed and unexposed sides after more than 30 years' service.[2]

The intermediate alloy layer in this material was remarkably well developed; the section of the exposed surface shows that the coating has been quite uniformly corroded away and at the point where the section was taken the inner strata of the alloy layer still remained intact.

Inasmuch as these alloy layers are never found in two of the types, the sprayed and the electrodeposited, the resistance of articles covered with such coatings to corrosion depends upon the thickness of such coatings and to the uniformity of the thickness. The variations which may be expected in this feature of these two types of coatings have been discussed above.

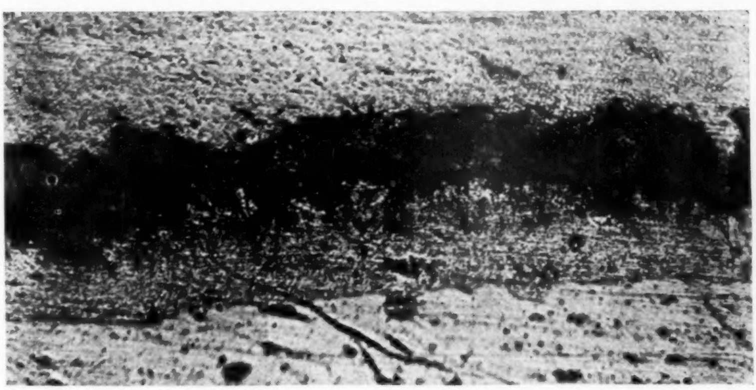
Like most intermetallic compounds, the layers of $FeZn_7$ and $FeZn_3$ are relatively hard and brittle. Fig. 4 (*a*) shows

[1] The data were taken from Vigouroux, Ducelliez and Bourbon; Bull de la Soc. Chem. de France, 4th Series, Vol. II, p. 480.

[2] This material was from the Panama Canal Zone, being a sample of material used by the French during their work there.

how slight bending will develop fine cracks in these layers (though it is possible that some of these cracks are similar to those in sherardized coatings and are due to contraction upon

(*a*) Coating from the inner or unexposed surface.



(*b*) Coating from the outer or exposed surface.

FIG. 14.—Structure of Hot-Dipped Sheet which Stood more than 30 Years' Service (×500).

cooling). The compound $FeZn_3$ appears to be considerably harder than the other compound, so that coatings in which it is well developed are easily separated from the base metal by

sharply bending them. The fine crystallin condition of the electrolytic and the sprayed coatings probably exerts as great an influence as does the absence of any brittle layers, in such coatings, in preventing them from stripping loose from the base metal as is the case in thick coatings of the first type.

VI. SUMMARY.

1. The microstructural features of the four types of commercial zinc coatings, the hot-dipped, sherardized, sprayed and electrodeposited, are described and compared with the coating obtained when iron is held for a relatively long period in contact with molten zinc and in which conditions approaching equilibrium are obtained.

2. Both hot-dipped and sherardized coatings are fairly complex in their structure, considerable alloying with the iron having taken place. The other types have a very simple structure.

3. The alloy layers stand in the same general relation to iron in their electrolytic potential as does zinc itself, though not to the same degree; and hence they do not accelerate the corrosion of the iron base, though they may cause the outer zinc to disappear at a somewhat more rapid rate than if they were not present.

4. The mechanical properties of the hot-dipped coatings are influenced considerably by the degree to which the alloy layers are developed. This appears to depend more upon the time which the sheets are held in the bath rather than upon the mere thickness of the coating.

5. The uniformity of thickness of the coating in the case of the simple types (electrolytic and sprayed), together with the average thickness, appear to be principal factors determining the efficiency of such coatings. Great variations in thickness in the electrolytic deposits may occur; even on flat surfaces variations in thickness of considerable magnitude were found.

APPENDIX IV.

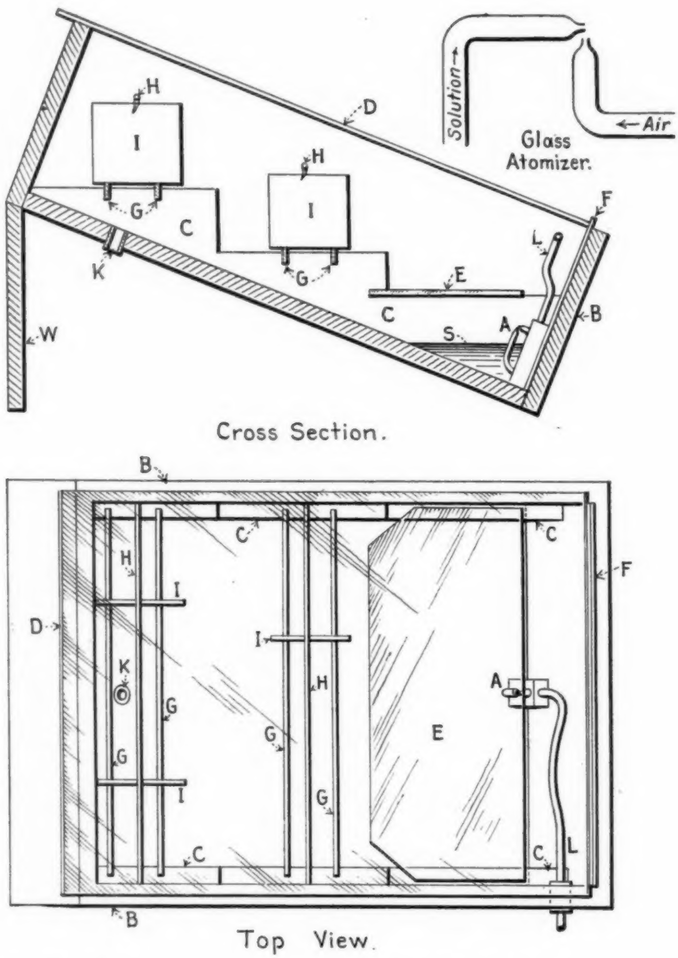
METHOD OF MAKING THE SALT-SPRAY CORROSION TEST.

BY A. N. FINN.

A corrosion test is the only real criterion of the value of a protective coating. The salt spray test, first described by J. A. Capp,[1] approaches a practical corrosion test more closely than any other so far described.

The operation of the salt spray test has received considerable attention at the Bureau of Standards during the past two years, and although all types of protective coatings have been tested, special attention was given to the zinc coatings. The test as conducted at the Bureau of Standards is made in an Alberene stone box, with a glass cover and glass supports for the samples. The construction is indicated in Fig. 1. The stone box is inclined so that drops of solution collecting on the cover will run down instead of dripping on the samples. A 20-per-cent solution (by weight) of commercial sodium chloride, filtered if necessary, is used with an air pressure of about 6 or 7 lb. per sq. in. which produces a very fine mist from the salt solution. The compressed air is passed through a glass-wool or cotton plug and then through water to remove oil and dust, and to saturate the air with water vapor which prevents concentration of the salt solution and crystallization of the salt on the tips of the atomizer. The baffle plate prevents the salt spray from blowing directly against the test pieces. The samples are washed with gasoline and ether to remove all grease before testing and are placed in the salt spray box in a vertical position on the glass rods or strips. They are removed from the bath every 24 hours, and washed with water, using a moderately stiff bristle brush. After drying, they are carefully examined

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part II, p. 475.



A - Atomizer.
B - Stone Box.
C - Cut Stone Supports for Samples.
D - Heavy Glass Top.
E - Glass Baffle Plate.
F - Glass Plate to Support "D."
G - Glass Strips to Support Samples.
H - Overhead Support for Samples.
I - Samples.
K - Opening for Exhaust.
L - Air to Atomizer.
S - Salt Solution.
W - Blocks to Support Box.

FIG. 1.—Alberene Stone Box for Making the Salt-Spray Corrosion Test.

for the presence of red or yellow iron rust. The first appearance of rust indicates the conclusion of the test, but valuable information may be obtained by continuing the test and observing the extent of the corrosion produced by longer exposure.

If Alberene stone is not available the box can be made of glass, stoneware, porcelain, waterproofed wood or any other insoluble and non-corrosive material. All connections should be of glass or rubber.

No definite statement can be made concerning the life of a zinc coating in this test, except in a general way. A sample showing rust spots in less than one day (24 hours) should be regarded as unsatisfactory, while a life of two or three days would indicate a coating that could safely be used under moderate conditions of exposure. A life of at least four to six days should be required for severe conditions of exposure.

DISCUSSION

Mr. Gibboney. MR. J. H. GIBBONEY (*Chairman of Inspection Committee*).—In closing the presentation of the report of the Inspection Committee, I wish to say that the committee has refrained from any direct statement with reference to the relative values of any particular metals; at this time they do not feel that the test has progressed sufficiently far for conclusive results to be stated. We have been cautious in presenting this matter and we think that it is one in which caution should be observed. We can well afford to wait for the test of service to prove conclusively just what can be expected from these various types of metal.

Lt.-Col. Cushman. LT.-COL. A. S. CUSHMAN.—As a member of this committee who has given close attention to the study of corrosion problems, I want to point out the necessity for caution in reaching conclusions from the inspection of photographs of sheets rusting out of doors. It is perfectly possible to take photographs at a certain stage in the progress of rusting of two sheets which, if examined side by side, would lead to the conclusion that the better sheet was the worse. What I fear about this progress report, interesting and valuable as it is from a scientific point of view, is that it may have the effect of inducing a number of people who are, of necessity, much interested in long-lived sheet metal, to form conclusions ahead of time. I think that every member of our committee would agree with me that there is no intent or purpose at this time to reach conclusions as to the comparative merits of different types of steel or iron exposed under these tests.

We all know that ferrous metals have to go into service all over the world under conditions which vary so much that it is almost impossible for us to reach conclusions from bare metal tests out of doors which can be carried into the general field of interpretation as to what chemical analysis is the best for all possible conditions. Ferrous metals in thin sections

exposed to extreme conditions of attack from the atmosphere are almost invariably covered with some sort of coating, either zinc or tin, or some other metallic coating, or if that is impossible or too expensive, paint coatings are resorted to; so I think that in interpreting these tests, which are bare metal tests in the open, we should interpret them wisely and conservatively, always holding in mind just exactly what they are and how far they go and that they should not be interpreted in any sweeping manner. **Lt.-Col. Cushman.**

If all of us in this Society will appreciate these tests and interpret them with those thoughts in our minds, they will be of great scientific value to us and will act as a guide in many ways in the course of our attempt throughout the future to prevent the rapid oxidation, decay and wastage of ferrous metal when rolled into thin gage sections, either sheet or wire.

MR. R. P. DEVRIES.—I should like to ask Mr. Gibboney whether the committee was unanimous in rejecting, for corrosion tests, those sheets which did not show up very well under the chemical tests and probably also under whatever physical tests were made. The only reason I have for asking is that, as every metallurgist probably well knows, material does not always show up in practice as we would expect it to, due to chemical or physical tests that have been made upon it, and as I am very much interested, not in metal sheets but in the general application of tests and the deductions we may make from scientific tests, I should like to have him answer that question fully. **Mr. Devries.**

MR. GIBBONEY.—The record shows that every sheet has been individually examined for carbon, manganese, phosphorus, sulfur and silicon, and that tests have been made to determine the presence or absence of nickel and chromium. A standard chemical specification or range for the various elements was adopted and applied to the series A or the type tests. The series B sheets were supplied by the manufacturers, and in some cases the results of chemistry did fall outside of the specifications, but not to such an extent as would be considered material. **Mr. Gibboney.**

MR. DEVRIES.—Were certain sheets rejected because they did not come up to the chemical specifications? **Mr. Devries.**

Mr. Gibboney.

MR. GIBBONEY.—A few sheets from certain lots were discarded, the rejection being primarily for surface imperfections. The chemical and physical inspection was made on all sheets, and some 78 sheets were rejected out of a total of 1800, but such rejections were based primarily on surface imperfections.

Mr. Buck.

MR. D. M. BUCK.—In answer to Mr. Devries, the committee adopted certain weight limits above or below which sheets were to be rejected. With the exception of one, or perhaps two, sheets, which were rejected on account of slight surface imperfections, all of the sheets under discussion were thrown out because they were outside the weight limits.

Mr. Voorhees.

MR. S. S. VOORHEES (*Chairman of Committee A-5*).—I should like to say, in answer to the remarks of Colonel Cushman, that we fully recognize that no conclusions have been reached, and we have been very careful so to state. The photographs shown on the screen were some of the photographs reproduced in the report. Practically all of these photographs illustrate what are considered failures. What is meant by failure is corrosion which has gone through the sheet, either at the lower edge or at some other point. The analyses of these sheets are reported. We recognize that the failures all occurred at Pittsburgh under the severe atmospheric conditions there. The condition of the sheets at Fort Sheridan and Annapolis was not the same as the condition of those at Pittsburgh, and we must wait for the results which I believe the next year will show. What they will be I cannot say, but I assure you that the committee is very careful not to draw conclusions that are not warranted.

REPORT OF COMMITTEE A-6

ON

MAGNETIC PROPERTIES.

Committee A-6 has held no meetings during the past year. In 1916 the committee proposed certain revisions in the Standard Tests for Magnetic Properties of Iron and Steel (A 34–14)[1]. These revisions were approved by the Society and printed as tentative that year[2], with the understanding that in 1918 they would be subject to adoption as standard. These revisions are repeated for convenience in the Appendix to this report. The committee accordingly recommends that they be referred to letter ballot of the Society for adoption as standard.

This report has been submitted to letter ballot of the committee, which consists of 12 members, of whom 10 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

CHARLES W. BURROWS,
Chairman.

EDITORIAL NOTE.

The proposed revisions in the standard tests referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on August 26, 1918. The tests as thus revised appear in the 1918 Book of A.S.T.M. Standards.

[1] 1916 Book of A.S.T.M. Standards, p. 243.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVI, Part I, p. 580 (1916).

APPENDIX.

PROPOSED REVISIONS

IN

STANDARD TESTS FOR MAGNETIC PROPERTIES OF IRON AND STEEL.

The following revisions of the Standard Tests for Magnetic Properties of Iron and Steel were proposed in 1916, and are now recommended for adoption as standard:

Strike out the last two paragraphs, which read:

"The standard test for rods intended for permanent magnets shall consist in the measurement of the magnetizing force, the residual induction, and the coercive force corresponding to a maximum induction of 14,000 gausses.

"Standard tests shall be made by the Burrows compensated double-yoke method (described in the *Standard Electrical Engineer's Handbook*, and also in *Technical Paper No. 117 of the Bureau of Standards*).",

and insert the following:

Residual Induction and Coercive Force.

The magnetic induction which exists in a piece of magnetic material when the magnetizing force has been reduced to zero is called the residual induction. The magnetizing force required to reduce this induction to zero is called the coercive force. The values of the residual induction and the coercive force depend upon the previous magnetic history. If the magnetic material has been normalized by proper demagnetization and repeated reversals of the magnetizing force, the corresponding quantities are called the normal residual induction (B_r) and the normal coercive force (H_c).

The standard data for material intended for permanent magnets shall consist of the normal induction (B), the

normal residual induction (B_r), and the normal coercive force (H_c) corresponding to a magnetizing force of 200 gausses.

The standard magnetic data shall be determined by the Burrows compensated double-yoke method on test specimens prepared as indicated below.

The permeameter opening shall have a rectangular cross-section of 2 by 5 cm. (0.79 by 1.97 in.).

Sampling.—Each mill heat or lot shall be marked separately. The test sample shall consist of one test specimen from each of six different bars.

Size of Test Specimen.—The test specimen shall be 25 cm. (9.84 in.) or more long and shall be of such cross-section that it will pass through a rectangular tube whose cross-section is 2 by 5 cm. (0.79 by 1.97 in.).

Heat Treatment.—For steels of the following approximate chemical composition:

Carbon	0.50 – 0.70	per cent
Manganese	0.50 – 1.00	"
Phosphorus	0.05	"
Sulfur	0.03	"
Silicon	0.10	"

heat the specimen to 825° C. (1517° F.) and quench in water at 20° C.

For tungsten steel, heat the specimen to 845° C. (1550° F.) and quench in water at 20° C.

For other alloy steels, the heat treatment is to be determined by practical tests on the test specimen.

The furnace shall be of such size that the specimen is heated to the required temperature in not over 30 minutes.

The furnace temperatures given above shall not vary by more than 10° C.

On quenching, the test specimen shall be removed quickly from the furnace. The test specimen shall not be allowed to cool over 10° C., after leaving the furnace and before immersion.

Immerse end-on or edgewise. The quantity of water shall be such that after quenching its temperature is not over 50° C.

REPORT OF COMMITTEE B-2
ON
NON-FERROUS METALS AND ALLOYS.

At the last meeting of the committee, held at the end of March, the reports of the seven sub-committees were presented and approved.

SUB-COMMITTEE I—ON PURE METALS IN INGOT FORM.

In pursuance of the report of the sub-committee presented by Mr. W. H. Bassett, chairman, the committee recommends that the tentative revision of the Standard Specifications for Spelter (B 6–14), which was accepted as tentative at the last annual meeting and published among the Tentative Standards[1], be referred to letter ballot for adoption as standard, to supersede the present standard.

There is no new work to be reported on either copper or zinc. The sub-committee has organized divisions on copper, zinc, lead, tin and antimony.

SUB-COMMITTEE II—ON WROUGHT METALS.

In pursuance of the report of the sub-committee presented by Mr. W. Reuben Webster, chairman, the committee makes the following recommendations:

1. That the Tentative Specifications for Brass Forging Rod (B 15–17 T)[2] be referred to letter ballot for adoption as standard.

2. That the Tentative Specifications for Free-Cutting Brass Rod for Use in Screw Machines (B 16–17 T)[3] be amended by changing the line in Section 3 now reading "Iron not over 0.10 per cent," to read "Iron not over 0.15 per cent," and that the specifications as thus amended be referred to letter ballot for adoption as standard.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 615 (1917).
[2] *Ibid.*, p. 603.
[3] *Ibid.*, p. 606.

3. That the following three new specifications, appended hereto,[1] be accepted for publication among the Tentative Standards of the Society:

(a) Specifications for Cartridge Brass;
(b) Specifications for Cartridge Brass Disks;
(c) Specifications for Naval Brass Rods for Structural Purposes.

SUB-COMMITTEE III—ON SAND-CAST ALLOYS.

In pursuance of the report of the sub-committee presented by Mr. W. M. Corse, chairman, the committee recommends that the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent (B 10–15 T)[2] be amended as indicated below, and referred to letter ballot for adoption as standard:

1. Add the following new Section 4, and re-number the remaining sections:

> "4. An analysis of each melt shall be made by the manufacturer. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3."

2. *Section 5.*—Change to read from its present form, namely:

> "The alloy shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	33 000
Elongation in 2 in., per cent	14"

to read:

> "The alloy shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	30 000
Yield point, " "	15 000[3]
Elongation in 2 in., per cent	14"

[1] See pp. 472–481.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 585 (1917).

[3] This value was deleted at the annual meeting. See Addendum to this report, p. 260. —ED.

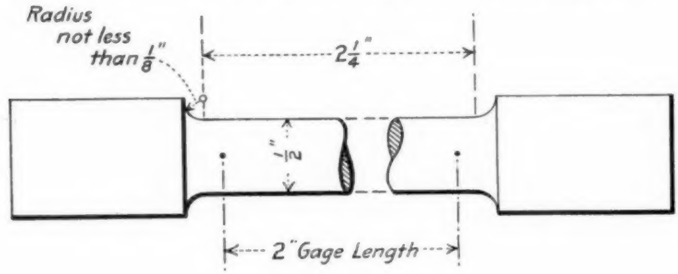
3. *Section 6 (c)*.—Change from its present form, namely:

"The tension test specimen turned down from the test bar shown in Fig. 1, shall be of the form and dimensions shown in Fig. 2.",

to read:

"Tension test specimens, turned from the test bar shown in Fig. 1, shall conform to the dimensions shown in Fig. 2. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial."

Insert the following Fig. 2 to replace the existing one:



Note:- The Gage Length, Parallel Portions and Fillets shall be as Shown, but the Ends may be of any Form which will Fit the Holders of the Testing Machine.

FIG. 2.

4. *Section 8*.—Change from its present form, namely:

"If the purchaser's tests show that the material does not conform to the requirements specified in Section 3, the manufacturer shall have the opportunity to inspect the material and each party shall select a sample for retest. If the results do not agree, they shall select the sample to be sent to a mutually agreeable umpire, whose decision shall be final. The cost of retests shall be paid by the loser.",

to read:

"9. (*a*) Inspection may be made at the manufacturer's works where the castings are made, or at the point at which they are received, at the option of the purchaser.

"(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the

purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

"10. Castings which show injurious defects revealed by machining operations subsequent to acceptance may be rejected, and if rejected, shall be replaced by the manufacturer free of charge to the purchaser. The full weight of the original material rejected shall be returned to the manufacturer."

Proposed Tentative Specifications for Bronze Bearing Metals for Turntables and Movable Railroad Bridges are appended hereto,[1] with the recommendation that they be printed among the Tentative Standards of the Society.

These specifications were based on those of the American Railway Engineering Association, modified at the convention of that association in March. This modification referred entirely to the chemical and physical properties. The chemical composition is given in the following table:

	Grade.			
	A.	B.	C.	D.
Alloy of	Copper and Tin.	Copper and Tin.	Copper, Tin and Lead.	Copper, Tin and Zinc.
Copper, per cent	Remainder	Remainder	82 (max.)	89 (max.)
Tin, max., per cent	20	17	11	11
Lead, max., per cent	....	....	11	....
Zinc, max., per cent	....	....	....	2.25
Phosphorus, per cent	1.0 (max.)	1.0 (max.)	1.0 (max.) 0.7 (min.)	0.25 (max.)
Other elements, max., per cent	0.5	0.5	0.5	0.5

The chief objection of the association to the former draft lies in the use of the word "about."

Committee B-2 feels there is little to choose between giving

[1] See pp. 482–486.—ED.

a maximum percentage and an approximate composition which is controlled by the physical properties.

SUB-COMMITTEE IV—ON WHITE METALS.

Mr. G. H. Clamer, chairman of the sub-committee, presented proposed Tentative Specifications for White Metal Bearing Alloys (known commercially as "Babbitt Metal"), which the committee appends hereto with the recommendation that they be printed among the Tentative Standards of the Society.[1]

These specifications embrace a series of twelve alloys, which may be modified as experience may dictate. While the specifications are by no means complete, it is hoped that their presentation may develop valuable discussion. Attention is directed to the physical properties appended to these specifications as information which serves to indicate the properties to be expected from the various alloys.

In view of the fact that there is a shortage of tin and that the Government is taking up the question of specifications for railroad bearings, it is recommended that the lead-base Babbitt metals Nos. 8 to 12 be used wherever possible. During the last few years practical experience has shown that in very many uses the tin-base bearing metals can be replaced by the lead-base metals with excellent results.

SUB-COMMITTEE V—ON PLATES, TUBES, AND STAYBOLTS FOR LOCOMOTIVES.

In pursuance of the report of the sub-committee, Mr. W. Reuben Webster, chairman, the committee recommends that the following tentative specifications[2] be referred to letter ballot for adoption as standard:

Tentative Specifications for Copper Plates for Locomotive Fireboxes (B 11–16 T);

Tentative Specifications for Copper Bars for Locomotive Staybolts (B 12–16 T);

Tentative Specifications for Seamless Copper Boiler Tubes (B 13–16 T);

Tentative Specifications for Seamless Brass Boiler Tubes (B 14–16 T).

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[1] See pp. 487–491.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats. Vol. XVII, Part I, pp. 588–602 (1917)

SUB-COMMITTEE VI—ON NON-FERROUS ALLOYS FOR RAILWAY EQUIPMENT.

Mr. G. H. Clamer, chairman of the sub-committee, recommended in its behalf that certain changes be made in the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment in Ingots, Castings, and Finished Car and Tender Bearings (B 17–17 T),[1] by which the four bearing metals (Nos. 1 to 4, inclusive) shall be changed to three.

They recommend that these specifications remain tentative because of the fact that there is still some doubt as to the proper limits of composition for the above alloys.

The following facts were presented before the meeting of Committee B-2:

1. The desirability of having a hard alloy for those bearings which are subjected to alternating or impact loads is now well recognized. That such an alloy is desirable was supported by evidence presented by the chairman, and by the correspondence of Messrs. W. M. Corse, W. K. Frank, H. V. Wille, and J. C. Ramage—all members of Sub-Committee VI—and also by the correspondence of Mr. J. T. Wallis, General Superintendent of Motive Power, Pennsylvania Railroad.

2. The desirability of using a softer alloy than Bearing Metal No. 2 for driving brasses, truck brasses, and hub liners, was agreed to.

3. The committee was practically unanimous in its opinion that the zinc content in Bearing Metal No. 4 is too high for best practice, and favored a compromise between alloys Nos. 3 and 4.

It was finally agreed that Tentative Specification B 17–17 T be revised to cover three bearing metal alloys instead of four, and that the use of each of these alloys be specific, thus eliminating confusion which might easily result if two alloys are specified for the same service as in the present specifications.

The committee accordingly recommends that the specifications be amended as indicated below, and continued as tentative because there is still some doubt as to the proper limits of composition for the alloys:

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 610 (1917).

1. Change the first three paragraphs of Section 1 (*b*), namely:

"(*b*) These alloys and the purposes for which they are frequently used are as follows:

"*Bearing Metals No. 1 and No. 2*, for connection-rod bearings, bushings, eccentric straps, driving-box bearings, trailer-truck bearings, crosshead gibs, hub liners and miscellaneous bushings;

"*Bearing Metals No. 3 and No. 4*, for lead-lined bearings, for locomotive tenders, freight and passenger car equipment."

to read:

"(*b*) These alloys and the purposes for which they are used are as follows:

"*Bearing Metal No. 1*, for connecting-rod bearings, bushings, eccentric straps, crosshead gibs, and miscellaneous bushings;

"*Bearing Metal No. 2*, for driving-box bearings, engine-truck and trailer bearings, and hub liners;

"*Bearing Metal No. 3*, for lead-lined bearings, for locomotive tenders, freight and passenger-car equipment."

2. Change the table of chemical composition from its present form, namely:

Alloy.	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, per cent.	Iron, max., per cent.	Antimony, per cent.	Phosphorus, max., per cent.	Aluminum, per cent.	Sulfur, max., per cent.	Total Impurity, excluding Zinc, per cent.
Bearing Metal No. 1.	remainder	9–11	9–11	1.5[a]	0.4	0.5[a]	....	none	....	1.0
Bearing Metal No. 2.	remainder	7–9	14–16	1.5[a]	0.4	0.5[a]	....	none	....	1.0
Bearing Metal No. 3.	remainder	7–9	14–16	3.0[a]	0.4	0.5[a]	....	none	....	1.0
Bearing Metal No. 4.	remainder	4–6	15–20	5.0[a]	0.4	0.5[a]	....	none	....	1.0
Bell Metal..........	remainder	16–18	0.25[a]	0.25[a]	0.25	0.25[a]	0.02	none	0.05	0.5
Babbitt Metal......	0.5[a]	9–11	remainder	0.10[a]	0.05	15–17	....	none	....	0.75
Lining Metal........	0.5[a]	4–6	remainder	0.10[a]	0.05	9–11	....	none	....	0.75

[a] Maximum.

to read:

Alloy.	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, max., per cent.	Iron, max., per cent.	Antimony, per cent.	Phosphorus, max., per cent.	Sulfur, max., per cent.	Arsenic, max., per cent.	Total Impurities, including Zinc, max., per cent.
Bearing Metal No. 1	remainder	9–11	9–11	0.75	0.25	0.25[a]	1.0[b]	....	....	1.0
Bearing Metal No. 2	remainder	4–6	23.5–26.5	0.75	0.40	0.50[a]	....	....	....	1.5
Bearing Metal No. 3	remainder	4–6	17–22	2.50	0.40	0.50[a]	....	....	....	3.0
Bell Metal	remainder	16–18	0.25[a]	0.25	0.25	0.25[a]	0.02	0.05	....	0.50
Babbitt Metal	0.50[a]	9.25–10.75	remainder	none	....	14–16	....	....	0.20	0.75[c]
Lining Metal	0.50[a]	4.50– 5.50	remainder	none	....	9.25–10.75	....	....	0.20	0.75[c]

[a] Maximum.
[b] Not considered an impurity, and can be specified at option of purchaser.
[c] Must not contain zinc.

The requirements covering Babbitt Metal and Lining Metal have been revised to conform with alloys Nos. 7 and 9, respectively, of the proposed Tentative Specifications for White Metal Bearing Alloys (known commercially as Babbitt Metal), referred to under the heading "Sub-Committee IV—On White Metals" and appended to this report.[1] The requirements covering Bell Metal are unchanged.

It will be noted that in Bearing Metal No. 1, phosphorus is not considered an impurity and can be specified at the option of the purchaser.

SUB-COMMITTEE VII—ON METHODS OF ANALYSIS.

In pursuance of the report of this sub-committee, presented by Mr. W. A. Cowan, chairman, the committee recommends that the Tentative Methods for Analysis of Alloys of Lead, Tin, Antimony and Copper (B 18–17 T)[2] remain tentative and be subjected to critical test in comparison with other methods, particularly that of T. J. Demorest,[3] as modified by F. A. Stief.[4]

For this purpose Mr. E. J. Feininger, acting for Mr. J. A.

[1] See pp. 487–491.—ED.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 622 (1917).
[3] *Journal of Industrial and Engineering Chemistry*, Vol. V, p. 842.
[4] *Ibid.*, Vol. VII, p. 211.

Capp, has prepared a standard sample which is to be analyzed by the proposed methods or other suggested methods by the members of the committee and by other chemists whose cooperation we are able to obtain. Portions of the standard sample have already been sent to Professor T. J. Demorest, of the Ohio State University, Mr. F. A. Stief of the Hoyt Metal Co., and Mr. R. S. MacPherran of the Allis-Chalmers Manufacturing Co.; and Dr. W. F. Hillebrand of the Bureau of Standards has been requested to cooperate in critically testing the methods with the use of the standard sample.

The committee also recommends that the proposed Tentative Methods for Chemical Analysis of Manganese Bronze and the Tentative Methods for Chemical Analysis of Gun Metal, appended hereto,[1] be published among the Tentative Standards of the Society. These methods are used in the laboratories of some brass and bronze producers, and will be critically tested by members of the committee and other chemists who have consented to cooperate.

The "persulfate" method for the determination of manganese in Manganese Bronze is recommended and the "bismuthate" method is given as optional. For the purpose of comparing these methods a standard sample of drillings of manganese bronze was prepared by Mr. Alden Merrill, of the American Brass Co., and distributed to the members of the sub-committee. The results obtained in this investigation formed the basis of the committee's recommendation and are given in the Appendix to this report.

SUB-COMMITTEE VIII—ON ALUMINUM AND ALUMINUM ALLOYS: CAST AND WROUGHT.

Sub-Committee VIII, under the chairmanship of Mr. P. D. Merica, has begun work on proposed Tentative Specifications for Aluminum Ingot, Aluminum Sheet and Aluminum for Castings. This work has already been begun by the International Aircraft Standards Board, who have adopted the following specifications in cooperation with the representatives of the allied governments and with manufacturers, which have been followed by the Signal Corps of the War Department:

[1] See pp. 523–537.—ED.

1G1..........General Specifications for the Testing and Inspection of Metallic Materials.
2N1 (1917)...Specifications for Ingot Aluminum;
3N12.........Specifications for Sheet Aluminum;
3N16.........Specifications for Aluminum Alloy Sheet;
3N11.........Specifications for Aluminum Alloy Castings;
3N17 (1918)..Specifications for Aluminum Alloy Tubing.

It is hoped that a report of progress of Sub-Committee VIII can be prepared in time for presentation at the annual meeting.[1]

The analysis of the letter ballot vote is as follows:

Items.	Affirmative.	Negative.	Not Voting.
TENTATIVE STANDARDS TO BE ADOPTED AS STANDARD.			
1. For Spelter (B 6-17 T)	33	2	32
2. For Brass Forging Rod (B 15-17 T)	28	0	39
3. For Free Cutting Brass Rod (B 16-17 T)	29	0	38
4. For Alloy Cu. 88, Sn. 10, Zn. 2 (B 10-15 T)	26	2	39
5. For Copper Plates (B 11-16 T)	29	0	38
6. For Copper Bars (B 12-16 T)	29	0	38
7. For Copper Boiler Tubes (B 13-16 T)	27	0	40
8. For Brass Boiler Tubes (B 14-16 T)	28	0	39
PROPOSED REVISIONS IN TENTATIVE STANDARDS.			
9. For Non-Ferrous Alloys for Railway Equipment (B 17-17 T)	27	2	38
PROPOSED NEW TENTATIVE STANDARDS.			
10. For Cartridge Brass	26	1	40
11. For Cartridge Brass Disks	27	1	39
12. For Naval Brass Rods	29	0	38
13. For Bronze Bearing Metals for Turntables	30	2	35
14. For White Metal Bearing Alloys (Babbitt Metals)	28	1	38
15. Methods for Chemical Analysis of Manganese Bronze	31	0	36
16. Methods for Chemical Analysis of Gun Metal	30	0	37

This report has been submitted to letter ballot of the committee, which consists of 67 members, of whom 34 have voted affirmatively, 2 negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

WM. CAMPBELL,
Chairman.

EDITORIAL NOTE.

For Addendum to this report, see page 260.
For Discussion, see page 262.

[1] See Addendum to report, p. 260.—ED.

APPENDIX.

DETERMINATION OF MANGANESE IN MANGANESE BRONZE.

March 27, 1918.

Mr. W. A. Cowan, Chairman, Sub-Committee VII,
National Lead Co.,
Brooklyn, N. Y.

Dear Sir:

In connection with the work of Sub-Committee VII, and as agreed in the meeting of the sub-committee held on February 9, 1918, I secured a piece of manganese bronze, and samples of drillings from it were sent to the several members of the sub-committee for the purpose of trying out the "persulfate" and the "bismuthate" methods for the determination of manganese.

The metal, according to our analysis No. 845, had the following composition:

Copper	59.49	per cent.
Zinc (by difference)	38.94	"
Lead	0.19	"
Tin	0.77	"
Iron	0.53	"
Manganese	0.08	"

We first determined manganese using four different methods, the Persulfate, the Bismuthate, the Ford-Williams, and Ford's method gravimetrically, finally weighing pyrophosphate.

In the persulfate method it was very soon found best to use a more dilute solution of sodium arsenite than that which was originally recommended, if concordant results were to be obtained in standardizing. Some of the arsenite was made up half strength, and some was made up quarter strength, and the manganese was determined in two samples of cupro-nickel, using the different strengths of sodium arsenite. Good agreement was obtained between the two solutions, the only question seeming to be which was the more convenient to use. With

the half-strength arsenite, 1 cc. was equivalent to approximately 0.00050 g. of manganese; with the quarter-strength arsenite, 1 cc. was equivalent to approximately 0.00025 g. of manganese.

The following figures were obtained:

	Arsenite.	
Sample No.	Half Strength.	Quarter Strength.
1431	0.164 per cent.	0.160 per cent.
1431	.....	0.163 "
1432	0.269 "	0.257 "
	0.274 "	.....

Mr. Price noted that while the more dilute solution was good for manganese bronze, it was much more difficult to use on cupro-nickel, probably on account of the color given by the nickel to the solution. We agree with Mr. Price on this point. The weaker solution can be used, but the end-point is not very easy to see except after considerable practice. In the standard method I believe it best to use the half-strength sodium arsenite, of which 1 cc. is equivalent to approximately 0.00050 g. of manganese. By using this medium strength a more easily detectable end-point is secured than can be obtained with the weaker solution. A larger volume of solution is used than when the original strength solution is taken, thus reducing errors of reading and securing better checks in standardizing. In the determination of manganese in the sample of manganese bronze using the persulfate method, the following percentages of manganese were obtained, using 1-g. samples:

	Analysis No. 969.
	0.082 per cent.
	0.081 "
	0.080 "
	0.081 "
	0.081 "
	0.082 "
Average	0.081 "

Manganese was next determined by the bismuthate method, using the method as given in Price & Mead's "Technical Analysis of Brass," second edition, pages 124–125. The permanganic acid formed was in one set of samples reduced by

ferrous ammonium sulfate, and the excess of this reagent was titrated with potassium permanganate. The following values for manganese were obtained, using 2-g. samples:

ANALYSIS No. 968.	
	0.073 per cent.
	0.070 "
Average.......	0.072 "

In another set of samples run by the bismuthate method the permanganic acid formed was reduced by standard sodium arsenite as in the persulfate method. The following figures were obtained, using 2-g. samples:

ANALYSIS No. 968.	
	0.079 per cent.
	0.080 "
Average.......	0.080 "

The third method used was the Ford-Williams, in which 5-g. samples were employed. The following figures were obtained by this method:

ANALYSIS No. 970.	
	0.078 per cent.
	0.072 "
	0.074 "
	0.073 "
Average.......	0.074 "

We had always found that results by this method were very slightly low, and on that account believe that the foregoing figures may be slightly below the true value.

Finally, manganese was determined gravimetrically as pyrophosphate using Ford's method and 5-g. samples; the following figures were obtained:

ANALYSIS No. 971.	
	0.077 per cent.
	0.082 "
Average.........	0.080 "

Finally, the persulfate, bismuthate and gravimetric methods using the arsenite reduction all agree very well as is shown by the following figures:

Method.		Manganese, per cent.
Persulfate		0.081
		0.081
		0.082
		0.082
		0.081
		0.080
Bismuthate		0.079
		0.080
Gravimetric		0.077
		0.082
	Average	0.0805

The Ford-Williams method and the Bismuthate method using a ferrous reducer have given results somewhat below these, but sufficiently close for commercial control work.

The figures which were obtained in the Laboratory of the National Lead Co., as given in your letter of March 16 to me, showed very good agreement between the persulfate and the bismuthate methods, and these results were very close to those obtained by us. For purpose of comparison they are given below:

Method.		Weight of Sample, g.	Manganese, per cent.
Persulfate	Strong Arsenite	1.0	0.082
	" "	1.5	0.084
	Weak (1-4)"	1.5	0.082
Bismuthate		1.0	0.081
		2.0	0.080
Average			0.082

It therefore seems best to recommend the persulfate method on account of its speed and simplicity, and to include the bismuthate as an optional method. You will note that we have included both methods in the Tentative Methods for the Analysis of Manganese Bronze which have just been sent out to the members of the sub-committee.

Yours very truly,

ALDEN MERRILL.

ADDENDUM

TO

REPORT OF COMMITTEE B-2.

In presenting the report of Committee B-2, the chairman, Mr. William Campbell, presented the following additional recommendations of the committee which had been agreed upon at a meeting held Wednesday afternoon, June 26:

1. In the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc 2 per cent (B 10-15 T), delete the proposed new requirement that the yield point shall be 15,000 lb. per sq. in. (See page 247.)

2. In the proposed Tentative Specifications for Bronze Bearing Metals for Turntables and Movable Railroad Bridges, change the chemical requirements to agree with those of the American Railway Engineering Association (see page 249), with the exception that the requirement of iron for Class D of "not over 0.2 per cent" shall be retained. Also change the physical requirements as follows: Class A, deformation limit minimum 24,000 lb. per sq. in., permanent set 0.06–0.12 in.; Class B, deformation limit minimum 18,000, permanent set 0.10–0.20; Class C, omit deformation limit; Class D, omit deformation limit, change the tensile strength from 30,000 to 33,000 lb. per sq. in., and specify the yield point "to be recorded."

3. That the proposed Tentative Specifications for Aluminum Ingots for Remelting and for Rolling, for Aluminum Sheet, and for Light Aluminum Casting Alloys, which had been prepared subsequent to the preparation and distribution of the report of Committee B-2 in preprint form, be accepted for publication among the tentative standards of the Society, provided the subsequent letter ballot of the committee on them should be carried without a dissenting vote.

4. In the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment, etc. (B 17-17 T), change the maximum

percentages of total impurities in the proposed new bearing metals Nos. 1 and 2 from 1 and 1.5 to 1.5 and 2 per cent, respectively. (See discussion of the report, page 266.)

EDITORIAL NOTE.

The eight tentative specifications referred to in the report and recommended for adoption as standard were approved at the annual meeting, including revisions recommended in the report and in the above addendum, and were subsequently adopted as standard by letter ballot of the Society on August 26, 1918. They now appear in the 1918 Book of A.S.T.M. Standards.

The seven proposed tentative specifications referred to in the report were accepted for publication as tentative, including the revisions in the Tentative Specifications for Bronze Bearing Metals referred to in the above addendum, and appear on pages 472-491 and 510-537.

The result of the letter ballot on the three tentative specifications referred to in the addendum was in each case affirmative without a dissenting vote, and the specifications therefore appear among the tentative standards of the Society on pages 492-501.

The revision in the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment recommended in the addendum to the report was not approved at the annual meeting and the specifications were continued as tentative in their proposed revised form as recommended in the report of the committee pages 251-253. The specifications as thus revised appear on pages 467-471.

DISCUSSION.

Discussion on Specifications for Babbitt Metals.

Mr. Campbell.

Mr. William Campbell (*Chairman of Committee B-2*).—In the proposed Tentative Specifications for White Metal Bearing Alloys (known commercially as "Babbitt Metal")[1] twelve alloys are specified. Some members of the committee felt that twelve alloys were far too many to include in a specification, and that four alloys would be ample. On the other hand, it was brought out that at present we are using several hundred different Babbitt metals; and the personal factor comes in so strongly, especially the question of trade mark and brand, that the committee finally decided that in reducing the number of Babbitt metals to twelve, they had taken a big step in the right direction, and that a further reduction could not be made this year. During the coming year, it may be possible to reduce this number materially.

Attention is called especially to the table of physical properties, appended to the specifications as information. The values in this table are subject to revision; in fact, the different members are still at work on this question, and it is hoped that by next year practically correct values may be published.

Mr. Clamer.

Mr. G. H. Clamer.—It might be in order to have a few remarks in connection with these specifications, particularly in regard to the fact that the table of alloys covers twelve formulas, instead of a smaller number as has been suggested. It is realized that the physical properties, with the exception of the degree of fluidity of a number of the alloys which are fairly close in composition, are sufficiently close to eliminate them.

Some babbitts are used for very thin linings, others for thick linings. Babbitt metals Nos. 1 and 2 have almost the same hardness and resistance to compression, but there is a great difference in the degree of fluidity in the two alloys. It is possible to use the No. 1 alloy, which contains 91 per cent of tin,

[1] See p. 487.—Ed.

Mr. Clamer.

for casting bearings of exceedingly thin section. The No. 2 alloy has less fluidity, and therefore cannot be used in liners of such thin section. The No. 3 alloy has still less fluidity, etc. The table of physical properties gives values of melting points and the complete liquation points, but these figures do not indicate absolutely that property of a babbitt metal which permits of its being cast into a liner of fairly large area and small cross-section. It is becoming generally recognized that a bronze bearing with a very thin liner gives most satisfactory results in the construction of automobile and aeroplane motors, transmissions, etc. It is for this reason that the table contains a greater number of alloys than it otherwise would. It was found by the committee that the alloys containing between 65 and 20 per cent of tin were decidedly inferior in their physical properties to the alloys above and below those having such tin content; the intermediate alloys have very low compressive strength, and they soften at a very low temperature due to the high amount of eutectic alloy which they contain.

There is another feature which I wish to speak of, and that is the matter of the conservation of tin, which is now giving the Government a great deal of concern. I have recently attended a number of meetings called to consider this matter. There has been organized a War Service Association of Babbitt and Solder Manufacturers, whose function is to give advice and suggestions in connection with the use of a smaller amount of tin in alloys wherever it is possible. The matter of tin conservation was brought up at the March meeting of Committee B-2. It was the consensus of opinion at that time—and I believe it has also been the policy with other committees—that we should not recommend specifications which are to cover the war period only. Our specifications are proposed for a period extending until they shall have been modified by proper action, and it was thought, therefore, that any changes in the specifications which might be considered of advantage in the interest of the conservation of tin for the duration of the war might be the subject of agreement between the purchaser and the producer. I believe, however, that a note such as was suggested at the meeting yesterday, relating to the phosphorus and sulfur requirements in the steel specifications, would be quite advantageous in directing attention to the necessity of conserving tin.

DISCUSSION ON SPECIFICATIONS FOR NON-FERROUS RAILWAY EQUIPMENT.

Mr. Campbell.

MR. CAMPBELL.—The report of the committee contains recommended revisions in the Tentative Specifications for Non-Ferrous Alloys for Railway Equipment in Ingots, Castings and Finished Car and Tender Bearings (B 17-17 T), the effect of which is to replace the present bearing metals Nos. 1 to 4, inclusive, by three bearing metals, each specified for a particular purpose. These proposed revisions and the reasons for submitting them are stated in detail in the report.[1] At the meeting of the committee held yesterday it was decided to recommend that the percentages of impurities for the proposed new bearing metals Nos. 1 and 2 be changed from 1 and 1.5 per cent, respectively, to 1.5 and 2 per cent.

I would accordingly move that the proposed revisions in these specifications, as thus amended, be adopted and the revised specifications continued as tentative for another year.

Mr. Clamer.

MR. CLAMER.—I was invited yesterday to attend the meeting of the Executive Committee, together with the other new members of the committee, to familiarize ourselves with the workings of that committee and the matters which were being discussed at the present time. For this reason, I was unable to attend the meeting of Committee B-2 held at the same time, as I felt it my duty to accept the invitation of the Executive Committee. Mr. Campbell has referred to making minor changes in the specifications. Now, a change of 0.5 per cent of zinc from 1 per cent is a change of 50 per cent in the impurity content, and although it may be minor numerically, it may have a very important effect on the qualities of the material specified. It seems to me that this is a matter which requires some further investigation. There has been considerable trouble on railroads within the past few years with the rod brasses for which alloy No. 1 is specified, in that breaking has resulted, due to impact strains. With the increasing weights and speeds of the locomotive equipment, it seems that the best is really none too good. I have seen a number of instances where 80-10-10 alloys have been used with impurity contents not exceeding those of our

[1] See pp. 251–253.—ED.

own specifications, in which failure has resulted due to cracking, so that at the present time there is under consideration by at least three of our large railroads, the question of going to a still higher tin content alloy. Increasing the zinc content is a step in that direction, but we do not want to take that step and at the same time increase the brittleness of the alloy. With 10 per cent of tin, the effect of zinc in an increasing amount is very marked in the direction of increased brittleness. I have made a great many tests of different copper and tin alloys with varying tin content, and have found that the permissible zinc content, without causing brittleness, becomes increasingly greater as tin diminished. It is exceedingly dangerous to permit higher zinc content than the specifications originally called for in the presence of as much as 10 per cent of tin. **Mr. Clamer.**

The increase in the zinc content is still more greatly emphasized in the presence of phosphorus: numerically phosphorus and zinc make a very poor combination. There are numerically comparatively few railroads using the phosphor-bronze alloy at the present time; but in the extent of the equipment controlled by these railroads there is, as a matter of fact, a great deal of phosphor-bronze used. The effect of zinc with phosphorus is to form a very hard scale on the casting. It eats into the sand very badly, is very hard to machine and is very hard on the tools, so that, taking these matters into consideration, it seems to me rather unwise at this time to raise the content of impurity, which can have no other justification than the lower cost of production. It means that a greater amount of scrap can be used, and with that, there is some question as to whether we would not be sacrificing the service which the castings would give. Personally I feel that probably 1.5 or even 2 per cent may not be across the danger line if phosphorus is not present, but I am certain that it is across the danger line with phosphorus specified in amounts between 0.7 and 1 per cent. The specifications, in allowing impurities up to 1 per cent, admit of the use of a certain amount of scrap, which is advantageous because the railroads return their scrap to the manufacturers; but increasing the zinc to 1.5 per cent I think would be taking chances. I would suggest, therefore, that this matter be either referred

Mr. Clamer. back to the committee for further consideration, or at least that we have some further discussion on this subject.

I note also that the committee recommends that the zinc content in alloy No. 2, or rather the impurity content, be increased from 1.5 to 2 per cent. This increase would probably not seriously affect the physical properties of that alloy owing to its low tin content. I think, therefore, that 2 per cent maximum impurity in this alloy would be perfectly satisfactory. I do not feel that the alloy with 2 per cent of zinc would be in any way inferior to the alloy with 1.5 per cent of zinc, but if the lead content is up to 26.5 per cent, or near that limit, lead segregation is apt to result. The Master Car Builders' Association have a similar specification, which admits of 3 per cent of zinc with the upper limit of lead given as 33 per cent. It would be absolutely impossible to make an alloy with lead and zinc both at the high limit as allowed in those specifications. I feel, therefore, that we are keeping on the safe side in this alloy also in restricting it to 1.5 per cent as was originally proposed by the committee and voted on at its meeting in March.

Mr. Campbell. MR. CAMPBELL.—The question which came up at the meeting of the committee yesterday was whether we should accept the proposed changes as given in the preprint of the committee's report,[1] or refer the whole matter back to Sub-Committee VI, which would mean that the alloys in the present specifications would remain tentative for another year. Now it was unanimously felt that the latter alloys ought not to remain tentative, and that those proposed in the report were infinitely superior. One or two of the members, however, felt that the impurity limits of alloys Nos. 1 and 2 should be increased, as I have said, to 1.5 and 2 per cent, respectively, and the members of the committee present voted to recommend these higher figures. But unfortunately most of the members of Sub-Committee VI were unable to be present.

Mr. Clamer. MR. CLAMER.—Probably we can come to an agreement in the following manner: My particular objection to the 2-per-cent limit on impurities is directed to alloy No. 1 if phosphorus is also specified. I am not quite sure that we will be on the danger

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[1] See pp. 251–253.—ED.

line in having 2 per cent of zinc if phosphorus is absent, but I am sure that we are over the danger line if we have 2 per cent of zinc with the phosphorus present. The specifications provide that for alloy No. 1 phosphorus shall not be considered an impurity and can be specified at the option of the purchaser. One could hardly call an element that had been specified by the purchaser an impurity, but if the specifications can be so worded that the phosphorus shall be included in the 2 per cent when phosphorus is present, I will withdraw my objection. Since these specifications are still tentative, I am sure that further investigation along the lines which we have discussed will be of advantage to the committee, and probably next year we can come to a final decision in the matter. **Mr. Clamer.**

MR. J. A. HANCE.—In regard to the impurities in the No. 1 mixture, I might say that it has been our practice for a number of years to keep the impurities below 2.75 per cent. In going over a number of railroad specifications on our file, we find some that allow 2 per cent and some that allow more than 2 per cent, some as high as 3 per cent of impurities, including zinc. **Mr. Hance.**

We think at this time it is very hard to obtain in large quantities bearing metals with the total impurities below 1 per cent where zinc is included. The proposed specifications provide for 0.75 per cent of zinc; that would leave a very small margin for the remainder of the impurities in the metal.

I might mention, incidentally, that, at the meeting of the committee yesterday, a new lining steel composed of lead and antimony was proposed to take the place of the lining metal now used which contains about 4.5 to 5.5 per cent of tin.

MR. E. J. EDWARDS.—For the past ten or fifteen years the American Locomotive Co., has had a specification for bearings which permitted 1.5 per cent impurity in the alloy corresponding to No. 1. In No. 2 we allow 3 per cent impurities. We have never had any trouble with our bearings. **Mr. Edwards.**

MR. A. W. GIBBS.—Metal No. 1 is for rod bearings. With the present locomotives the performance from hot pins is becoming very unsatisfactory. Locomotive delays from all causes are tabulated and among those showing a marked and steady increase is the heating of crank pins. **Mr. Gibbs.**

The designer of locomotives is very much cramped in pro-

Mr. Gibbs. viding proper crank pins, for the reason that an increase in the diameter is at the expense of the metal in the crank between the axle fit and the crank-pin fit, both of which are forced. Too great an increase in the size of the crank pins involves the cracking of the wheel center. As a result the pins are rather small and the pressures consequently high.

If the presence of zinc will increase the liability of cracking of the brasses, I think that the zinc should be restricted, as rod brass trouble is at present a very serious source of detention.

[Mr. Campbell's motion was then put to a vote and lost.]

Mr. Edwards. MR. EDWARDS.—I move that the specifications be continued as tentative in their present form as published in the 1917 Proceedings, and that the committee be requested to give further consideration to the revisions proposed in its report.

Mr. Clamer. MR. CLAMER.—I do not think that is a proper motion, because if it is referred back to the committee, it will be on consideration of the amended specifications, and it would mean that we would have to stand on the old specifications for another year. Those specifications are quite faulty, and the objections raised to them are well founded. The specifications are not specific. Two compositions are given for the same use, alloys Nos. 1 and 2 for locomotive wearing parts and Nos. 3 and 4 for car and tender bearings. At the option of the purchaser either one of those alloys could be used. This led to confusion, particularly in connection with the building of foreign equipment—at least that is my understanding—and for that reason the matter of revision was taken up by the committee and the specifications put in the form as proposed in the printed report of the committee. They are now absolutely specific; each of alloys Nos. 1, 2 and 3 is used for a specific purpose. I think it will therefore be quite serious to go back to the old specifications without their revision.

Mr. Capp. MR. J. A. CAPP.—The whole discussion seems to be hinging about the question, Shall we adopt the revisions proposed by the committee in its printed report, without further amendment? The committee was nearly unanimous on its letter ballot vote on these revisions. We have just voted not to accept

the additional amendments of the impurity figures for alloys Nos. 1 and 2. It seems to me that the wise thing to do is to accept the unanimous recommendation of the committee. I would therefore move to amend Mr. Edward's motion, by continuing the specifications as tentative in their proposed revised form. **Mr. Capp.**

[The motion as amended was then carried.]

REPORT OF COMMITTEE C-1

ON

CEMENT.

Since the last annual meeting of the Society, Committee C-1 on Cement has held two meetings. One meeting was held in Allentown, Pa., on October 25, 1917, in cooperation with a meeting of Committee C-9 on Concrete and Concrete Aggregates, and, including the inspection trips, was both a profitable and pleasant meeting. The next meeting was held on January 18, 1918, in the United Engineering Building in New York City. At these two meetings some important matters were discussed and several important phases of the work of the committee were passed upon. In order to avoid an April meeting, as called for by the rules of the committee, some of the work was deputized to members to be carried on during the interval between the meeting and the annual meeting of the Society. This action was taken because of the pressure of war-time calls upon the members.

In reviewing the work of the committee during the year it should be said that it is quite apparent that these times are so occupying the time and minds of the members that serious individual attention to committee matters is apt to be difficult. The sub-committee reports to the committee show each sub-committee to be merely caring for its immediately pressing matters, but each is also storing up its material and data for future consideration. This applies particularly to the sub-committees on Fineness, Time of Setting, and Strength. There are, however, some few questions that have been considered which are of particular interest to members of this Society and to such of the public as have learned to depend upon the work of this Society.

A subject which has occupied the interest of many members has been that of the publication in a report of Committee C-1 of the reports and data upon which the present Standard

Specifications and Tests for Portland Cement are founded and which this committee intends to have published for the information of the members of the Society. There has been accumulated a fine collection of valuable data that should be in a permanent form both for the information and as a matter of record. There has been a disappointing delay in the publication of this report. It is still in the hands of sub-committees, some of whom are endeavoring to so compile and edit these data that the report will contain all possible information and will also be published within the amount of the funds this committee has available for the purpose.

The Tentative Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9–16 T)[1] are still as proposed by the committee and accepted by the Society at the annual meeting in 1916. The committee finds that it is not ready at this time to present any recommendations regarding these specifications, except to recommend that they be continued as tentative. When the stress of the present relaxes and makes possible a further consideration of these specifications, Committee C-1 will again take up the study of the data secured. In the meantime the committee will appreciate the interest shown if any one who may have data on this subject, or suggestions or criticisms of these specifications, will kindly send them to the secretary of this committee.

Committee C-1 also has endeavored to study a revision of the Standard Specifications for Natural Cement. A sub-committee has been appointed to consider this, but there has been little interest shown in general by those who would naturally be expected to be most interested. It is hoped, however, that an opportune time will come for active consideration of these specifications.

Committee C-1 has also been asked several times concerning the absence in the present specifications of any requirements for tensile strength of neat cement. An endeavor has been made to explain through correspondence the reasons for such absence. When the report, to which reference was made above, is published we believe that the data therein will satisfy any questioning minds on this subject. Several other questions

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 630 (1917).

in regard to the specifications have been answered in order to make clear their intent and meaning.

In conclusion, Committee C-1 recommends solely at this time that the Tentative Specifications and Tests for Compressive Strength of Portland-Cement Mortars be continued as tentative.

This report has been submitted to letter ballot of the committee, which consists of 54 members, of whom 48 have voted affirmatively, none negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

RUSSELL S. GREENMAN,
Chairman.

P. H. BATES,
Secretary.

EDITORIAL NOTE.

The tentative specifications referred to in this report were continued as tentative and appear on pages 538–541.)

REPORT OF COMMITTEE C-2

ON

REINFORCED CONCRETE.

Committee C-2 on Reinforced Concrete reports that at its meeting on June 27, 1917, it was agreed to proceed to prepare specifications for reinforced concrete, with the thought that standard specifications on this form of construction are desirable. Pursuant to this action, the Executive Committee was requested to take steps to secure the cooperation in this work of the several societies cooperating in preparing the Joint Committee Report on Reinforced Concrete. Action on this request has been deferred by the Executive Committee, for reasons which it is understood will be fully presented in the report of that committee to the Society at the annual meeting. No progress has been made towards the preparation of the proposed standard specifications.

At a meeting held in New York on October 17, 1917, a closure was prepared of the discussion of the report of the Joint Committee, which duly appeared in Part I of the Proceedings, devoted to committee reports.

This report has been submitted to letter ballot of the committee, which consists of 11 members, of whom 6 have voted affirmatively, none negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

F. E. Turneaure,
Chairman.

Richard L. Humphrey,
Secretary.

REPORT OF COMMITTEE C-4

ON

CLAY AND CEMENT SEWER PIPE.

The committee has been doing active work during the past year. Numerous additional studies and investigations have been conducted by several special sub-committees. The officers of the committee have held four meetings during the year, and the committee held one meeting on March 5, 1918, attended by thirteen members. At this meeting were considered the reports of the sub-committees, as well as other matters.

The committee recommends that the Tentative Specifications for Clay Sewer Pipe (C 13–17 T) and the Tentative Specifications for Cement-Concrete Sewer Pipe (C 14–17 T), published[1] as tentative during the past year, be revised as indicated in the Appendix to this report. The sub-committees appointed to report on abrasion, chemical tests and requirements, percolation, absorption, and detailed dimensions of sewer pipes, have been continued to report further necessary recommendations.

A special sub-committee is authorized to present, at the June meeting of the committee, a draft of a proposed specification consolidating all of the clauses at present contained in the two separate Tentative Specifications for Clay Sewer Pipe and for Cement-Concrete Sewer Pipe into one single combined specification, embodying both classes of sewer pipe.

It is recommended that both of the tentative specifications, with the modifications proposed herein, be continued as tentative for another year.

The committee further recommends that the Tentative Specifications for Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling (C 15–17 T) and the

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 634–658 (1917).

Tentative Recommended Practice for Laying Sewer Pipe (C 12–17 T), published[1] as tentative during the past year, be continued without amendment as tentative for another year.

This report has been submitted to letter ballot of the committtee, which consists of 23 members, of whom 19 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

RUDOLPH HERING,
Chairman.

A. J. PROVOST, JR.,
Vice-Chairman.

GEORGE T. HAMMOND,
Secretary.

EDITORIAL NOTE.

The proposed revisions in the Tentative Specifications for Clay Sewer Pipe and for Cement-Concrete Sewer Pipe, referred to in this report, were approved at the annual meeting. In addition a motion was passed at the annual meeting to omit the requirements for maximum absorption in each of these specifications, namely 5 per cent and 8 per cent respectively. (See Summary of Proceedings, page 34.) The specifications as thus revised were continued as tentative and appear on pages 542-566.

The two remaining tentative standards referred to in the report were continued as tentative and appear on pages 567-568 and 612-614.

For Addendum to the report, see page 280.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, pp. 659–660 and 701–703 (1917).

APPENDIX.

PROPOSED REVISIONS

IN

TENTATIVE SPECIFICATIONS FOR SEWER PIPE.

Committee C-4 recommends that the following revisions be made in the Tentative Specifications for Clay Sewer Pipe and in the Tentative Specifications for Cement-Concrete Sewer Pipe:

Tentative Specifications for Clay Sewer Pipe: C 13–17 T.

(*Proceedings*, Vol. XVII, Part I, pp. 634–646.)

1. *Table III, "Dimensions."*—Change the values in the fourth column on "Depth of Hub" to read as follows (the figures in brackets indicate present values to be revised):

Internal Diameter, in.		Depth of Socket, in.
6		2
8	[2½]	2¼
10		2½
12	[3]	2½
15	[3]	2½
18		3
21	[3½]	3
24	[3½]	3
27	[4]	3½
30	[4½]	3½
33	[5]	4
36	[5]	4
39	[5]	4
42	[5]	4

2. *Section 32.*—Change to read as follows by the insertion of the italicized words:

> "The ends of the pipes shall be square with their longitudinal axis, *except as provided in Table IV.*"

3. *Section 33 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

> "Curves shall be at angles of *90,* 45, $22\frac{1}{2}$ [$11\frac{1}{4}$] deg., as required."

4. *Table IV, "Permissible Variations in Dimensions."*—After the second column, insert a new column headed "Lengths of Two Opposite Sides, in.," as follows:

Normal Size, in.	Limits of Permissible Variation in Lengths of Two Opposite Sides, in.
6	$\frac{1}{8}$
8	$\frac{1}{8}$
10	$\frac{1}{8}$
12	$\frac{1}{8}$
15	$\frac{1}{8}$
18	$\frac{3}{16}$
21	$\frac{3}{16}$
24	$\frac{1}{4}$
27	$\frac{1}{4}$
30	$\frac{1}{4}$
33	$\frac{3}{8}$
36	$\frac{3}{8}$
39	$\frac{3}{8}$
42	$\frac{3}{8}$

5. Substitute the word "socket" for "hub" or "bell" wherever used in the specifications.

TENTATIVE SPECIFICATIONS FOR CEMENT-CONCRETE SEWER PIPE: C 14–17 T.

(*Proceedings*, Vol. XVII, Part I, pp. 647–658.)

1. *Section 31 (b).*—Change the first sentence to read as follows by the insertion of the italicized figure and the omission of the figure in brackets:

> "Curves shall be at angles of *90*, 45, 22½ [11¼] deg., as required."

2. *Table III, "Dimensions."*—Change the table to read as follows by the insertion of a new column headed "Normal Annular Space" and by replacing the matter in brackets by the words and figures indicated:

TABLE III.—DIMENSIONS OF CEMENT-CONCRETE SEWER PIPE

Internal Diameter, in.	Laying Length, ft.	Diameter at Inside of [Hub], *Socket*, in.	*Normal Annular Space, in.*	Depth of [Hub], *Socket*, in.	Taper of [Hub] *Socket*.	Minimum Thickness of Barrel, in.
6	2	[8½] 8¼	½	2	1 : 20	⅝
8	2, 2½, 3	[10⅞] 11	⅝	[2½] 2¼	1 : 20	[⅞] ¾
10	2, 2½, 3	13¼	⅝	2½	1 : 20	[1] ⅞
12	2, 2½, 3	[15½] 15⅝	⅝	[3] 2½	1 : 20	[1 3/16] 1
15	2, 2½, 3	19¼	⅝	[3] 2½	1 : 20	[1½] 1¼
18	2, 2½, 3	22¾	⅝	[3] 2¾	1 : 20	[1¾] 1½
21	2, 2½, 3	26½	¾	[3½] 2¾	1 : 20	[2] 1¾
24	2, 2½, 3	30¼	¾	[3½] 3	1 : 20	[2⅜] 2⅛
27	3	34	⅞	[4] 3¼	1 : 20	[2⅝] 2¼
30	3	38	1	[4½] 3½	1 : 20	[3] 2½
33	3	41½	1	[5] 4	1 : 20	[3¼] 2¾
36	3	[45¾] 45½	1¼	[5] 4	1 : 20	[3½] 3
39	3	[49¼] 49	1¼	[5] 4	1 : 20	[3¾] 3¼
42	3	[53¼] 53	1½	[5] 4	1 : 20	[4] 3½

[1] When pipes are furnished having an increase in thickness over that given in last column, the diameter of [hub] *socket* shall be increased by an amount equal to twice the increase of thickness of barrel.

3. *Table IV, "Permissible Variations in Dimensions."*—Change the values in the third and fourth columns, on "Spigot" and "Hub," to read as follows (the figures in brackets indicate the present values to be revised):

NORMAL SIZE, IN.	LIMITS OF PERMISSIBLE VARIATION IN INTERNAL DIAMETER, IN.			
	SPIGOT ±		SOCKET ±	
6		$\frac{3}{16}$	[$\frac{1}{4}$]	$\frac{3}{16}$
8		$\frac{1}{4}$	[$\frac{5}{16}$]	$\frac{1}{4}$
10		$\frac{1}{4}$	[$\frac{5}{16}$]	$\frac{1}{4}$
12	[$\frac{5}{16}$]	$\frac{1}{4}$	[$\frac{3}{8}$]	$\frac{1}{4}$
15	[$\frac{5}{16}$]	$\frac{1}{4}$	[$\frac{3}{8}$]	$\frac{1}{4}$
18	[$\frac{3}{8}$]	$\frac{1}{4}$	[$\frac{7}{16}$]	$\frac{1}{4}$
21	[$\frac{7}{16}$]	$\frac{5}{16}$	[$\frac{1}{2}$]	$\frac{5}{16}$
24	[$\frac{1}{2}$]	$\frac{5}{16}$	[$\frac{9}{16}$]	$\frac{5}{16}$
27	[$\frac{5}{8}$]	$\frac{5}{16}$	[$\frac{11}{16}$]	$\frac{5}{16}$
30	[$\frac{5}{8}$]	$\frac{3}{8}$	[$\frac{11}{16}$]	$\frac{3}{8}$
33	[$\frac{3}{4}$]	$\frac{3}{8}$	[$\frac{13}{16}$]	$\frac{3}{8}$
36	[$\frac{3}{4}$]	$\frac{1}{2}$	[$\frac{13}{16}$]	$\frac{1}{2}$
39	[$\frac{3}{4}$]	$\frac{1}{2}$	[$\frac{13}{16}$]	$\frac{1}{2}$
42	[$\frac{3}{4}$]	$\frac{1}{2}$	[$\frac{13}{16}$]	$\frac{1}{2}$

4. Substitute the word "socket" for "hub" or "bell" wherever used in the specifications.

ADDENDUM

TO

REPORT OF COMMITTEE C-4.

Since March 5, 1918, the committee has held four meetings during the present week (June 29). At these meetings the following transactions were the most important which took place:

The following sub-committees requested to be continued: Sub-Committee I on Absorption and Hydrostatic Pressure Test Requirements, H. T. Shelly, chairman; Sub-Committee II on Chemical Requirements, Coleman Meriwether, chairman; Sub-Committee IV on Certain Legal Definitions, W. S. Dickey, chairman; and Sub-Committee V on Glossary of Terms, H. P. Eddy, chairman. Sub-Committee III on Dimensions and their Permissible Variations, H. P. Eddy, chairman, was continued and its membership increased from five to nine members.

The Sub-Committees on Abrasion Tests and on Combined Specifications reported and were discharged.

The previous vote on the question of adopting separate or combined specifications was reconsidered, and it was ordered that a vote be not taken on this question until within six months after the end of the war.

One new member was added to Committee C-4 to equalize the number of producers of clay and cement-concrete sewer pipe, increasing the committee to 24 members.

Respectfully submitted,

RUDOLPH HERING,
Chairman.

REPORT OF COMMITTEE C-5
ON
FIREPROOFING.

Committee C-5 submitted to the Society last year a new Tentative Method for Control of Fire Tests and Classification of Materials and Construction as Determined by Test (C 19–17 T)[1]; also certain revisions of the existing Standard Tests for Fireproof Floor Construction (C 2–08) and for Fireproof Partition Construction (C 3–09).[2] In order that the proposed new standards should be as generally acceptable to the engineering world as possible, a series of conferences were inaugurated with representatives of the following technical organizations:

American Society for Testing Materials;
National Fire Protection Association;
U. S. Bureau of Standards;
National Board of Fire Underwriters;
Underwriters' Laboratories;
Associated Factory Mutual Fire Insurance Companies;
American Institute of Architects;
American Society of Mechanical Engineers;
American Society of Civil Engineers;
Canadian Society of Civil Engineers;
American Concrete Institute.

The recommendations of Committee C-5 last year comprised the joint action of the representatives of all the organizations named. The results were very gratifying, and the work has been continued this year in the same cooperative way. Two conferences have been held.

The U. S. Bureau of Standards and the Underwriters' Laboratories conducted numerous experiments during the year investigating the adaptability of the proposed Time-Temperature

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 679 (1917).

[2] 1916 Book of A.S.T.M. Standards, pp. 487–492. For revisions proposed, see *Proceedings*, Vol. XVII, Part I, p. 297.

Curve for the control of fire tests. The curve operated so satisfactorily it was unanimously voted to make no change in it, nor in any other essential feature of the proposed new requirements.

The standards have been rearranged and simplified to some extent for sake of clearness, and the revisions of existing standards have been amplified to make them more definite. These changes, however, have not altered the general purpose of the requirements as submitted in tentative form last year.

As the standards offered this year are intended to embody the Tentative Method published among the Tentative Standards during the past year, as well as the tentative amendments to the existing standards C 2–08 and C 3–09 which were included in the committee's report last year, it would appear that it is unnecessary for them to be again printed in tentative form. The committee therefore recommends that the proposed Standard Specifications for Fire Tests of Materials and Construction appended to this report[1] be referred to letter ballot of the Society for adoption as standard. The effect of their adoption will be to discontinue existing standards C 2–08 and C 3–09, and incorporate the whole subject of fire tests of materials and construction under one set of specifications.

It is expected that these specifications will be presented for adoption in the same form to the National Fire Protection Association in May of this year. They will also be presented for consideration at the June meeting of the American Society of Mechanical Engineers. The specifications are already in practical use by both the Underwriters' Laboratories and the U. S. Bureau of Standards.

This report has been submitted to letter ballot of the committee, which consists of 10 members, of whom 6 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

IRA H. WOOLSON,
Chairman.

R. P. MILLER,
Secretary.

[1] These specifications are not reprinted here, but appear in the 1918 Book of A.S.T.M. Standards.—ED.

ADDENDUM

TO

REPORT OF COMMITTEE C-5.

In presenting the foregoing report of Committee C-5 on Fireproofing the chairman, Mr. I. H. Woolson, recommended on behalf of the committee that the following changes be made in the proposed Standard Specifications for Fire Tests of Materials and Construction, as appended to the report:

1. *Section 6.*—Change to Section 9 to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "For any material or construction intended to carry load other than its own weight, [at least] the full rated safe working load shall be applied during the entire fire test, *also during the fire stream test. After completion of the fire stream test, the sample shall be subjected to excess loading as prescribed under specifications for the different structural parts.*"

2. *Section 7.*—Change to Section 6 to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "The fire test on the sample with its applied load, if any, shall be [either] continued until failure occurs, or [stopped at the period for which classification is desired, allowed to cool and loaded to failure.] *until it has withstood the test conditions for a period equal to $1\frac{1}{4}$ times that for which classification is desired.*"

3. *Section 8 (a).*—Change to Section 7 to read as follows by the addition of the italicized words and the omission of the words in brackets:

> "A second [and separate] test *with duplicate sample* shall be made to determine the effect of a hose

stream on a sample under fire test, the water being applied [not later than one hour after the beginning of the test] *at the end of a period equal to three-fourths of that for which classification is desired, but not later than one hour after the beginning of the test, except that for classification periods of one-half hour or less the fire stream test may be omitted.*"

4. *Section 8 (b).*—Change to Section 8 and add the following classifications in Table I:

Parts of Structure.	Type of Protection.	Size of Hose Nozzle, in.	Water Pressure at Nozzle, lb.	Time of Application, min.
Floors and Roofs	$\frac{1}{2}$ hour	$1\frac{1}{8}$	30	1
	$\frac{1}{4}$ "	$1\frac{1}{8}$	15	1
Walls, Columns and Partitions	$\frac{1}{2}$ "	$1\frac{1}{8}$	30	1
	$\frac{1}{4}$ "	$1\frac{1}{8}$	15	1

5. *Section 12.*—Change to Section 13 to read as follows by the insertion of the italicized words and the omission of the words in brackets:

"The floor shall be loaded [so as] *in a manner* to develop in each member of the construction stresses [up] *equal* to the maximum *safe* working stress allowed in the material of the member."

6. *Section 13.*—Change from its present form, namely:

"13. The test shall not be regarded as successful unless the following conditions are met:

"(*a*) No fire shall have passed through the floor or roof during the test.

"(*b*) The floor or roof shall have safely sustained the full rated safe working load during the test.

"(*c*) After a fire test that has not been carried to failure, or after a combined fire and water test, the floor or roof shall sustain safely the dead load plus at least $2\frac{1}{2}$ times the designed live load applied not less

than 24 hours nor more than 72 hours after the completion of the fire test.

"(*d*) If the fire test has been continued to failure, the failure shall not have occurred within a period of 25 per cent in excess of the period for which classification is desired.",

to read as follows:

"14. The test shall not be regarded as successful unless the following conditions are met:

"(*a*) The floor or roof shall have sustained safely the full rated safe working load during the fire test without passage of flame, for a period equal to 1¼ times that for which classification is desired.

"(*b*) The floor or roof shall have sustained safely the full rated safe working load during the fire steam test, as prescribed in Sections 7 and 8, without passage of flame, and after its completion shall sustain a total load equal to the dead load plus 2½ times the designed live load."

7. In Sections 15 and 16, change the word "sample" to "partition."

8. *Section 17.*—Change to Section 18 to read as follows by the addition of the italicized words and the omission of the words in brackets:

"The test shall not be regarded as successful unless the following conditions are met:

"(*a*) *The partition shall have withstood safely the fire test for a period equal to 1¼ times that for which classification is desired.*

"(*b*) *The partition shall have withstood the fire stream test as prescribed in Sections 7 and 8.*

"(*c*) No fire shall have passed through the partition during the *prescribed* fire [test] *periods.*

"(*d*) Transmission of heat through the [sample] *partition during the prescribed fire periods* shall not have been such as to raise the temperature on the outer surface of the [sample] *partition* in excess of 300° F.

"[The partition shall have safely sustained the pressure of the hose stream.]

"(*e*) The partition shall not have warped or bulged or disintegrated under the action of [the] fire or water to such an extent as to be unsafe."

EDITORIAL NOTE.

The proposed Standard Specifications for Fire Tests of Materials and Construction, referred to in this report, as amended in the addendum to the report, were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918. They appear in the 1918 Book of A.S.T.M. Standards. These specifications replace the Tentative Method for Control of Fire Tests and Classification of Materials and Construction as Determined by Test (C 19 – 17 T) proposed in 1917, as well as the Standard Tests for Fireproof Floor Construction (C 2 – 08) and the Standard Tests for Fireproof Partition Construction (C 3 – 09).

REPORT OF COMMITTEE C-8
ON
REFRACTORIES.

Committee C-8 has held three general meetings during the year. The following recommendations submitted by the respective sub-committees were approved for reference to letter ballot vote of the whole committee. The results of this vote are tabulated at the close of the report.

Sub-Committee I on Fusion Test.—This sub-committee has presented in outline a proposed tentative method, but has been unable to complete the material in time for presentation to the Society this year.

Sub-Committee II on Analysis.—As a result of a number of helpful criticisms, the committee recommends, in pursuance of the report of its sub-committee, that the following changes be made in the Tentative Methods for Ultimate Chemical Analysis of Refractory Materials (C 18–17 T)[1] and that the Methods be continued as tentative.

Proposed Revisions in Tentative Methods for Ultimate Chemical Analysis of Refractory Materials.

All page references refer to *Proceedings*, Vol. XVII, Part I (1917).

1. *Section 2, p. 672.*—Add to the end of the section:

"If preferred the sample may be dried in a weighing bottle, from which the required samples shall be weighed out."

2. *Section 10, p. 673.*—Between the first and second sentences insert the following:

"The ordinary chemical iron wire is not sufficiently pure for this use. If preferred the solution may be standardized against sodium oxalate, a pure form of which is prepared especially for such work by the U. S Bureau of Standards, Washington, D. C."

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 671 (1917).

3. *Section 13, p. 674, paragraph 2, line 4.*—After the word "dryness" insert: "take up with a little HCl and water, transfer to a new filter paper,"; and in the same line, after the word "Transfer" insert "both silica precipitates."

4. *Section 13, p. 674, paragraph 3.*—Omit the first three sentences, reading:

"To the residue in the crucible, add about 5 cc. of water and 5 drops of H_2SO_4 (the latter to prevent the formation of titanium fluoride). Evaporate to dryness. Again moisten with about 5 cc. of water and 5 drops of H_2SO_4.",

and substitute:

"To the residue in the crucible add about 5 cc. of water and 5 drops of H_2SO_4."

5. *Section 14, p. 674.*—At the beginning of the section insert:

"Regarding the determination of alumina, reference should be made to *Scientific Paper No. 286* of the U. S. Bureau of Standards by Dr. Blum on 'Determination of Alumina as Oxide.'"

6. *Section 14, p. 674, line 4.*—After the word "excess" insert the sentence: "The NH_4OH must be free from CO_2."

7. *Section 14, p. 675, line 12.*—Omit the following two sentences:

"Cool in a desiccator and then moisten with one drop of HNO_3 and heat gently until all fumes are gone. Blast again and weigh."

8. *Section 16, p. 676, line 4.*—After "H_2O_2" insert, in parenthesis, "free from fluorine."

9. *Section 18, p. 677.*—Add at the end the sentence:

"The $Mg_2P_2O_7$ is never pure, being contaminated by small amounts of calcium, barium, aluminum, iron, manganese, etc., but in the analysis of refractories this error is negligible and correction for these impurities is not required unless previously agreed upon."

10. *Section 19, p. 677, line 3 from bottom.*—Omit "The increase in weight is KCl + NaCl."

11. *Section 19, p. 677, last line.*—In place of "mixed chlorides" read "alkali chlorides."

12. *Section 19, p. 678, line 3.*—In place of "KCl" read "NaCl."

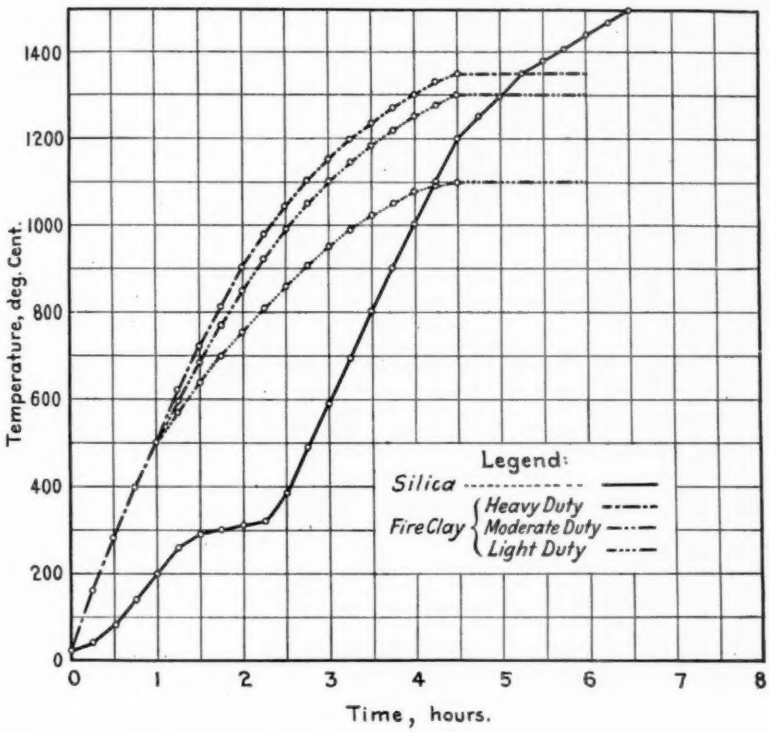

FIG. 1.—Time-Temperature Curve for Load Test.

Sub-Committee III on Industrial Survey.—This committee has no report to offer at this time.

Sub-Committee IV on Thermal Conductivity and Expansion.—The committee reports considerable progress on this subject, but has no formal report to make to the Society.

Sub-Committee V on Porosity and Permanent Volume Change.—This sub-committee has prepared a proposed Tentative Method for Determination of Porosity and Permanent Volume Changes in Refractory Materials. The committee recommends

TABLE. I.—TEMPERATURE TO BE ATTAINED AT TIME SPECIFIED.

ALL TEMPERATURES IN DEGREES CENTIGRADE.

Time,	Silica.	Fire Clay.		
		Heavy Duty.	Moderate Duty.	Light Duty.
Hr. Min.				
15	40	160	160	160
30	80	280	280	280
45	140	400	400	400
1 0	200	500	500	500
15	260	620	595	570
30	290	720	685	640
45	300	815	770	700
2 0	310	900	850	755
15	320	980	920	810
30	385	1045	990	860
45	490	1100	1050	905
3 0	590	1150	1100	950
15	695	1195	1145	985
30	800	1235	1185	1020
45	900	1270	1220	1050
4 0	1000	1300	1250	1075
15	1100	1330	1275	1090
30	1200	1350	1300	1100
45	1250	1350	1300	1100
5 0	1300	1350	1300	1100
15	1350	1350	1300	1100
30	1380	1350	1300	1100
45	1410	1350	1300	1100
6 0	1440	1350	1300	1100
15	1470	End	End	End
30	1500			
45	1500			
7 0	1500			
15	1500			
30	1500			
45	1500			
8 0	1500 End			

that this Method, which is appended to this report,[1] be accepted by the Society for publication as tentative.

Sub-Committee VI on Load Test.—As a result of a number of criticisms received during the year, the committee recom-

[1] See pp. 588–591.—ED.

mends, in pursuance of the report of its sub-committee, that the following revisions be made in the present Tentative Test for Refractory Materials under Load at High Temperatures (C 16–17 T)[1] and that it be continued as tentative:

Section 2 (a).—The committee recommends the use of a larger furnace, similar to that proposed by Robert J. Montgomery in *Metallurgical and Chemical Engineering,* Volume XVIII, No. 1, p. 18 (1918).

Section 5.—Change to read:

> "The rate of heating shall be in accordance with the requirements of Table I and the time-temperature curves of Fig. 1, which give the rate and time of heating suggested for different grades of material."

Sub-Committee VII on Spalling Action, which was discontinued for one year, has been reorganized.

Sub-Committee VIII on Slagging Action.—The committee recommends that the Tentative Test for Slagging Action of Refractory Materials (C 17–17 T)[2] be continued as tentative. While Sub-Committee VIII reported that there were several changes it desired to make in the tentative test, it was not prepared at this time to recommend them.

The results of the letter ballot vote of the committee on the above recommendations are as follows:

Recommendation.	Affirmative.	Negative.	Not Voting.
Relating to Existing Tentative Standards.			
Methods for Ultimate Chemical Analysis of Refractory Materials (C 18–17 T)	24	0	15
Test for Refractory Materials under Load at High Temperature (C 16–17 T)	25	0	14
Test for Slagging Action of Refractory Materials (C 17–17 T)	16	8	15
Proposed New Tentative Standard.			
Method for Determination of Porosity and Permanent Volume Changes in Refractory Materials	20	1	18

[1] *Proceedings,* Am. Soc. Test Mats., Vol. XVII, Part I, p. 665 (1917).
[2] *Proceedings,* Am. Soc. Test. Mats., Vol. XVII, Part I, p. 669 (1917).

This report has been submitted to letter ballot of the committee, which consists of 39 members, of whom 25 have voted affirmatively, none negatively, and 14 have refrained from voting.

Respectfully submitted on behalf of the committee,

A. V. BLEININGER,
Chairman.

W. H. FULWEILER,
Secretary.

EDITORIAL NOTE.

The Tentative Test for Refractory Materials under Load at High Temperatures, and the Tentative Methods for Ultimate Chemical Analysis of Refractory Materials referred to in this report, were continued as tentative in their proposed revised form and appear on pages 573–577 and 580–587, respectively. The Tentative Test for Slagging Action of Refractory Materials was also continued as tentative, without amendment, and appears on pages 578–579.

The proposed new tentative standard referred to in this report was accepted for publication as tentative and appears on pages 588–591.

REPORT OF COMMITTEE C-10
ON
HOLLOW BUILDING TILE.

The activities of Committee C-10 during the past year have been devoted entirely to the work of Sub-Committee I on Strength and Load Tests along the lines indicated in the report of last year. This report is therefore one of progress and is devoted to the activities of this sub-committee.

Since the last annual meeting of the Society there has been no occasion to hold a general meeting of Committee C-10, as the work has been a continuation of that already planned. Owing to existing conditions throughout the country it has been impossible to carry out, for the time being, many of the investigations contemplated.

Tests on walls are progressing, some having been completed, others are ready to test, and tile has been promised for another set. Having already made strength and absorption tests on individual tile from representative districts and with wall tests of tile from the Eastern district typified by the product from New York or New Jersey, the Central district by the product from the vicinity of Pittsburgh and the Western district by the product from the vicinity of Chicago, the committee will be in a position to deliberate upon tentative specifications.

The committee wishes to express its appreciation to the re-organized Hollow Building Tile Association, which has been instrumental in collecting existing data and securing tile for further tests, and to the manufacturers who have furnished tile with which to carry on our investigations.

The information in the appendix is merely a statement of results, as it is impossible at this time to draw any conclusions.

This report has been submitted to letter ballot of the committee, which consists of 15 members, of whom 13 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. H. Provine,
Chairman.

APPENDIX.[1]

TESTS OF HOLLOW BUILDING TILE.

TABLE I.—COMPRESSION TESTS MADE BY THE UNIVERSITY OF CALIFORNIA.

TILE FROM CALIFORNIA.

Size of Specimen, in.	How Tested.	Degree of Burning.	Net Section Area, sq. in.	Load at First Crack.		Maximum Load.	
				lb.	lb. per sq. in.	lb.	lb. per sq. in.
4 by 12 by 12....	End	Light	19.33	82 000	4230	82 000	4230
	"	Medium	18.89	92 000	4870	92 000	4870
	"	"	18.84	101 600	5390	101 600	5390
	"	"	18.89	88 000	4660	88 000	4660
	"	Hard	19.39	66 000	3410	81 600	4210
	Edge	Light	13.8	30 600	2220	30 600	2220
	"	Medium	13.5	34 200	2540	36 800	2720
	"	"	13.5	30 000	2220	34 600	2560
	"	"	13.4	38 000	2840	43 400	3240
	"	Hard	13.5	44 000	3260	44 000	3260
	Flat	Light	22.2	74 400	3350	74 400	3350
	"	Medium	27.0	75 700	2800	75 700	2800
	"	"	26.7	56 800	2130	56 800	2130
	"	"	22.5	84 000	3730	84 000	3730
	"	Hard	22.2	104 200	4700	104 200	4700
8 by 12 by 12....	End	Light	32.00	144 000	4500	144 000	4500
	"	Medium	32.15	150 100	4675	150 100	4675
	"	"	31.90	139 000	4360	139 000	4360
	"	"	33.23	141 700	4260	141 700	4260
	"	Hard	31.88	144 000	4510	151 000	4730
	Edge	Light	17.80	35 000	1965	41 500	2330
	"	Medium	17.90	49 000	2740	64 000	3570
	"	"	18.20	32 000	1760	52 000	2860
	"	"	18.20	41 000	2250	45 200	2480
	"	Hard	18.20	46 000	2525	54 400	2990
	Flat	Light	28.17	65 600	2330	65 600	2330
	"	Medium	27.00	77 800	2890	77 800	2890
	"	"	26.70	73 000	2730	73 000	2730
	"	"	26.40	68 000	2580	68 000	2580
	"	Hard	26.70	92 000	3440	92 000	3440

[1] For instructions for conducting physical tests of tile and tile walls, see *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part 1, p. 338 (1917).

TABLE II.—COMPRESSION TESTS
MADE BY
THE UNIVERSITY OF MICHIGAN.
TILE FROM KENTUCKY.

Size of Specimen, in.	How Tested.	Degree of Burning.	Net Section Area, sq. in.	Load at First Crack.[1] lb.	Load at First Crack.[1] lb. per sq. in.	Maximum Load.[1] lb.	Maximum Load.[1] lb. per sq. in.
	Edge	Hard	12.35	3 400	280	31 500	2550
	"	Medium	11.40	4 000	350	19 600	1720
	"	"	12.40	3 000	240	13 500	1090
	"	"	12.21	4 870	400	36 200	2960
	"	Light	12.95	3 100	240	14 500	1120
4 by 12 by 12....	Flat	Hard	24.30	5 500	230	22 700	940
	"	Medium	24.14	4 500	190	70 670	2930
	"	"	24.92	12 000	480	94 300	3790
	"	Light	22.80	7 500	330	54 360	2380
	End	Hard	19.51	38 400	1970	88 200	4500
	"	Light	20.36	10 000	485	39 200	1920
	Edge	Hard	13.46	14 000	1040	55 500	4120
	"	Medium	14.47	2 600	180	14 700	1030
	"	"	14.69	5 000	340	7 000	476
	"	"	13.92	8 500	610	48 800	3500
	"	Light	13.26	6 500	490	7 200	543
6 by 12 by 12....	Flat	Hard	26.64	4 300	160	67 300	2530
	"	Medium	25.32	9 200	360	54 400	2150
	"	"	26.72	7 200	270	81 700	3060
	"	"	26.16	7 100	270	80 700	3090
	"	Hard	25.82	6 600	260	39 800	1540
	End	Hard	23.24	66 200	2850	114 100	4900
	"	Medium	28.30	49 500	1750	91 600	3240
	Edge	Hard	23.62	16 000	680	59 600	2500
	"	Medium	23.52	3 500	150	42 500	1810
	"	"	23.22	2 800	120	58 500	2500
	"	"	23.83	4 100	170	40 500	1700
	"	Light	24.54	2 800	110	29 500	1200
8 by 12 by 12....	Flat	Hard	23.28	10 200	440	71 200	3160
	"	"	22.73	7 500	330	66 300	2920
	"	Medium	22.90	9 000	390	39 600	1730
	"	"	23.75	6 100	260	41 100	1730
	"	"	22.84	7 600	330	33 700	1480
	End	Hard	35.84	13 850	380	170 300	4750
	"	Light	36.66	24 100	656	82 500	2250

[1] The minimum speed of the testing machine used for these tests was more than that specified in the Instructions for the Physical Tests; see *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 340 (1917).

TABLE III.—ABSORPTION TESTS MADE BY THE UNIVERSITY OF CALIFORNIA.

TILE FROM CALIFORNIA.

Size of Original Tile, in.	Degree of Burning.	Average Dry Weight, g.	Wet Weight, g.	Absorption, per cent.
4 by 12 by 12	Light	290.00	340.20	17.30
	"	170.00	199.20	17.20
	"	372.80	430.00	15.30
	Medium	311.50	353.60	13.50
	"	289.80	327.20	12.90
	"	304.10	341.10	12.20
	Hard	177.70	197.20	11.00
	"	430.00	476.40	10.80
	"	349.80	388.70	11.10
8 by 12 by 12	Light	308.90	357.50	15.70
	"	187.70	218.00	16.10
	"	408.90	473.90	15.90
	Medium	605.40	686.80	13.40
	"	282.40	320.80	13.60
	"	546.30	618.60	13.20
	Hard	417.60	469.80	8.00
	"	293.70	329.10	12.10
	"	394.70	442.90	12.20

TABLE IV.—ABSORPTION TESTS MADE BY THE UNIVERSITY OF MICHIGAN.

TILE FROM KENTUCKY.

Size of Original Tile, in.	Degree of Burning.	Absorption, per cent.
4 by 12 by 12	Medium	8.6
	"	9.8
	"	8.2
6 by 12 by 12	Medium	23.0
	"	13.0
	Soft	22.0
8 by 12 by 12	Medium	7.2
	"	8.8
	"	14.1

REPORT OF COMMITTEE D-1

ON

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

Committee D-1 on Preservative Coatings for Structural Materials, which now has 94 members, has for the first time in a number of years held only one meeting since the annual meeting of the Society. In the latter part of 1917, the question of holding the regular fall meeting was considered and in view of the fact that so many of the members were much occupied with work in connection with the war, it was decided to omit the fall meeting. At the meeting held in Philadelphia on March 25, 1918, thirty members were present.

The committee recommends that the following Tentative Methods be submitted to letter ballot for adoption as standard:

1. Tentative Methods for Routine Analysis of Dry Red Lead (D 49–17 T).[1]

2. Tentative Methods for Routine Analysis of Yellow, Orange, Red and Brown Pigments containing Iron and Manganese (D 50–17 T).[2]

The committee further recommends that the following be published as tentative, with the understanding that they may be submitted to letter ballot for adoption as standard in 1919:

1. Tentative Specifications for Foots Permissible in Properly Clarified Pure Raw Linseed Oil from North American Seed. (See Report of Sub-Committee V.)

2. Tentative Test for Flash Point of Paint Thinners other than Turpentine. (See Report of Sub-Committee XI.)

Sub-Committee XIII on Shellac has been requested to take up the testing of cut shellac.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 796 (1917).
[2] *Ibid.*, p. 802.

Reports are appended from the following sub-committees:

Sub-Committee V on Linseed Oil;
" " VIII on Methods of Analysis of Paint Materials;
" " IX on Varnish;
" " XI on Paint Thinners other than Turpentine;
" " XIV on Preparation of Iron and Steel Surfaces for Painting.

This report has been submitted to letter ballot of the committee, which consists of 94 members; 37 ballots were cast, 57 not voting. The vote was taken on each section of the report. Following is the result of the ballot:

General Report	37	affirmative;	0	negative.
Report of Sub-Committee V	35	"	0	"
Report of Sub-Committee VIII	33	"	0	"
Report of Sub-Committee IX	31	"	0	"
Report of Sub-Committee XI	30	"	1	"
Report of Sub-Committee XIV	31	"	0	"

Respectfully submitted on behalf of the committee,

P. H. WALKER,
Chairman.

G. W. THOMPSON,
Secretary.

EDITORIAL NOTE.

The two tentative methods referred to in this report were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The two proposed tentative standards referred to in the report were accepted for publication as tentative and appear on pages 615–616 and 685–688.

REPORT OF SUB-COMMITTEE V ON LINSEED OIL.

Very little work has been done by the members of Sub-Committee V during the past year. It decided upon no definite outline, but asked that each member apply the foots test to as many samples of raw linseed oil as came to his hands, and to report as his work the results of these tests. Such reports are appended hereto.

Attention has been called by Mr. Seaton to the fact that the foots test and the break test do not always parallel. The incident was this: A sample of oil was received which showed but a fraction of a percent in the foots test, but behaved badly in some factory experiments. Examination proved that when this oil was heated to the breaking point—that is, the point at which gelatinous matter separates from it—there was a very large amount of this matter present. Evidently, the foots test does not measure certain substances of a detrimental character which may be present in solution in the oil.

Your chairman is in correspondence on the subject of the method for the determination of the iodine number with the Committee of the American Chemical Society, appointed to submit Standard Methods for the Sampling and Analysis of Commercial Fats and Oils. Their tentative methods recommend the use of the Wijs determination of the iodine value of an oil. We expect to have available for consideration, in the near future, a statement showing in greater detail than in the Committee's report their reasons for adopting the Wijs method.

The method of determining the percentage of foots in raw linseed oil as now developed is given in the accompanying specifications. A compilation of the results so far reported of the application of this test is given below:

Percentage of Foots.	Number of Samples.	Percentage of Total.
From 0 to trace	71	31.8
" trace to 0.4 per cent	44	19.7
" 0.4 to 0.8 "	30	13.5
" 0.8 to 2 "	57	25.6
Above 2 per cent	21	9.4
	223	100.0

The sub-committee believes that these data justify the drawing up of tentative specifications to cover the percentage of foots that shall be permissible in pure raw linseed oil from North American seed properly clarified. These specifications accompany this report,[1] and the sub-committee recommends that they be published among the Tentative Standards of the Society.

Respectfully submitted on behalf of the sub-committee,

GLENN H. PICKARD,
Chairman.

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[1] See pp. 615-616.—ED.

APPENDIX.

REPORTS OF ANALYSTS.

Report of Glenn H. Pickard.

In a table given below are the results of the examination of samples of linseed oil furnished by the various representative crushers of the United States. These results are, therefore, truly representative of the oil delivered to the consuming public from May 1, 1917 to April 1, 1918. The sub-committee's tentative method for the determination of foots has worked successfully in all instances, except in a few isolated cases where it was impossible to keep the laboratory warm and the determination was made at temperatures 60° F., or below. When this happened, the percentage of foots was excessive. Check tests on the same oils at normal temperatures showed lower results. There have been but two or three samples which behaved out of the ordinary when the foots test was applied. In each case the appearance of the precipitate was a whitish mass, closely resembling an emulsion. It would not settle closely, however, even though a long time was given. The shipments of oil behaving in this manner were closely watched in the factory, where no abnormal action was noted. We were unable to study these samples further to determine, if possible, the cause of this peculiar action. As a result of this work, we feel that the application of this test gives valuable evidence as to the oil quality.

Analytical Constants of Raw Linseed Oil.

North American.

Specific Gravity.	Iodine Number.	Acid Number.	Foots, per cent.
0.9350	189.8	2.6	0.4
0.9348	183.6	1.2	0.6
0.9352	188.8	2.2	0.0
0.9348	189.4	1.6	trace
0.9339	185.2	1.41	1.0
0.9355	191.4	1.4	0.4
0.9354	191.1	1.3	0.4
0.9348	188.6	2.6	0.6
0.9353	189.0	2.4	0.8
0.9341	189.0	2.6	0.0
0.9342	189.8	2.0	1.2
0.9340	187.5	2.0	4.0
0.9341	187.1	2.1	0.0
0.9342	182.7	3.5	0.8
0.9342	184.9	3.3	1.2
0.9345	186.0	1.5	0.4
0.9344	186.4	1.1	0.4
0.9341	184.9	1.5	0.4
0.9348	185.3	2.0	3.6
0.9348	183.6	3.5	0.8

NORTH AMERICAN.

Specific Gravity.	Iodine Number.	Acid Number.	Foots, per cent.
0.9351	186.3	3.0	0.4
0.9354	188.5	3.07	trace
0.9355	189.1	2.6	trace
0.9355	188.9	1.9	trace
0.9355	187.5	2.5	trace
0.9355	186.7	2.4	trace
0.9358	185.5	1.0	trace
0.9353	188.0	3.5	0.6
0.9354	188.0	1.8	0.6
0.9382	184.3	1.2	trace
0.9350	186.8	2.3	0.6
0.9358	187.9	1.7	1.2
0.9344	182.9	4.9	0.8
0.9332	185.5	2.1	trace
0.9355	187.9	2.0	trace
0.9354	189.3	2.0	0.8
0.9344	184.6	2.7	1.2
0.9344	185.3	2.4	1.6
0.9349	189.5	3.6	0.8
0.9351	188.1	3.3	trace
0.9351	188.7	2.5	0.0
0.9352	190.1	2.3	trace
0.9360	188.9	2.3	trace
0.9349	181.9	3.7	1.2
0.9355	186.2	2.2	trace
0.9348	188.3	2.4	trace
0.9344	183.7	2.2	1.2
0.9346	181.9	3.4	1.2
0.9343	184.8	2.17	1.6
0.9346	182.5	2.1	2.1
0.9345	184.1	2.2	2.4
0.9348	185.2	2.3	2.7
0.9345	181.9	1.8	3.2
0.9349	183.8	1.8	2.4
0.9346	184.1	1.9	2.0
0.9347	186.7	1.8	2.8
0.9344	187.7	2.6	2.0
0.9344	186.2	2.0	0.8
0.9342	183.5	2.8	1.2
0.9347	186.5	3.0	0.4
0.9342	181.4	2.6	2.0
0.9346	184.4	2.8	1.2
0.9340	184.8	2.2	0.0
0.9343	186.1	2.5	trace
0.9357	189.2	1.6	1.6
0.9347	187.6	1.8	0.4
0.9341	188.4	2.3	0.4
0.9353	194.3	1.4	0.0
0.9350	189.3	1.3	0.4
0.9337	184.4	2.4	2.4
0.9339	186.9	2.2	0.0

SOUTH AMERICAN.

0.9329	176.9	6.1	4.8
0.9331	173.9	2.3	4.0
0.9311	175.6	5.8	4.0
0.9314	167.9	5.18	2.4

SUMMARY.—NORTH AMERICAN OIL.

PERCENTAGE OF FOOTS IN OIL.	NO. OF SAMPLES.
From 0 to trace	23
" trace to 0.4 per cent	12
" 0.4 to 0.8 "	12
" 0.8 to 1.2 "	10
" 1.2 to 2 "	6
Above 2 per cent	8
	71

REPORT OF MAX Y. SEATON.

We have made foots tests on all oils received since the meeting of the American Society for Testing Materials, June, 1917. Percentages of foots have varied from 2.4 to a trace. This is a considerably better showing than that of the shipments of raw oil received during the previous six months. We receive comparatively few shipments of raw oil, as all we buy is in tank cars and our total consumption of oil is not extremely large, so we have not many results at hand.

One interesting feature has been noted in the fact that the foots test and the break test do not always parallel, an instance of which has been previously reported.

REPORT OF F. A. WERTZ.

I have done very little further experimental work on this test during the past year, but have been making the test on all samples received, and have been reporting all samples showing more than 2 per cent of foots as having an excessive amount of foots for ordinary use. The limit of 2 per cent is the one I suggested in my original report on this test. A summary of my results follows:

PERCENTAGE OF FOOTS IN OIL.	NO. OF SAMPLES.
None or not more than trace	48
More than trace, but not more than 0.4 per cent	28
More than 0.4, but not more than 0.8 "	15
More than 0.8, but not more than 2.0 "	27
More than 2 per cent	7
	125

The greatest amount of foots which I have found was 27.2 per cent. The results given above indicate, in general, the relative appearance of the oils as regards turbidity. Most of our difficulties in getting a sharp settling of foots has occurred in the oils containing large quantities and it appears that more accurate readings on very turbid oils might possibly be obtained by using a smaller volume of the oil for the test.

REPORT OF SUB-COMMITTEE VIII ON METHODS OF ANALYSIS OF PAINT MATERIALS.

Sub-Committee VIII reports as follows:

No criticism having been received of the Tentative Methods for Routine Analysis of Yellow, Orange, Red, and Brown Pigments containing Iron and Manganese (D 50–17 T), as published in the Proceedings,[1] it is recommended that these methods be submitted to letter ballot for adoption as standard.

It is also recommended that the Tentative Methods for Analysis of Dry Red Lead (D 49–17 T), published among the Tentative Standards of the Society,[2] be submitted to letter ballot for adoption as standard.

Respectfully submitted on behalf of the sub-committee,

F. W. SMITHER,
Chairman.

[1] Vol. XVII, Part I, p. 802 (1917).
[2] *Ibid.*, p. 796.

REPORT OF SUB-COMMITTEE IX ON VARNISH.

The needs of the Government for a rapid endurance test on varnishes prompted Mr. L. V. Pulsifer to offer his method to the Bureau of Standards for their consideration. The method proposed gave results of sufficient merit to warrant the chairman of Sub-Committee IX in bringing it to the attention of the members with the request that they try it out on at least three varnishes for which they already had endurance records.

A number of the sub-committee responded to this request, and the method as well as the suggestions and findings of those who carried out the test are reported herewith.

Elasticity Test.

1. Varnishes for Signal Corps use must pass the following accelerated elasticity test. Varnishes which pass this test will be immediately accepted, provided all the other requirements in the Signal Corps specifications for airplane Spar Varnish are met.

Acceptance of varnishes which do not pass this test will be held up pending the making of the exposure test specified by the Signal Corps. This applies both to samples originally submitted, and to all subsequent deliveries.

2. Method of making accelerated elasticity test is by the proportionate reduction of the elasticity of the varnish under test by the addition of a solution of No. 1 run Kauri in pure spirits of turpentine.

(*a*) Standard Kauri-Turpentine Solution is made as follows:

Arrange distillation flask—running water cooled condenser—and tared distillate receiver on balance. Place in flask about one-third of its volumetric capacity of clear bright pieces of No. 1 Kauri broken to about pea size. Melt and distill carefully until 25 per cent by weight is driven off. At the end of the distillation, the thermometer in the distillation flask, with bulb opposite the discharging point of this flask, should register approximately 700° F.

Pour the residue into a clean pan; when cold break up and dissolve (at temperature of approximately 300° F.) one part of the run Kauri in two parts of spirits of turpentine by weight. This solution should be made in a carefully tared beaker and brought back to correct weight when cold by the addition of the amount of spirits of turpentine necessary to replace the loss by evaporation during the dissolving of the gum.

(*b*) Very carefully determine the non-volatile content of the varnish under examination by an approved standard method.

Take 100 g. of the varnish, and add an amount of the standard Kauri-Turpentine solution equivalent to 50 per cent by weight of the amount of non-volatile matter in the varnish. Mix thoroughly cold.

Example.—If a varnish contains 45 per cent by weight of non-volatile matter, add to 100 g. of the varnish 22.5 g. of Kauri-Turpentine solution.

(*c*) Flow a coat of the varnish thus reduced on a tin panel of suitable size and weight (4 by 5-in., 100-lb. tin) carefully cleaned with benzol. Allow to dry in a nearly vertical position at room temperature for one hour. Then place in an oven at 200 to 212° F. in a horizontal position and bake for five hours at 200 to 212° F. Remove from oven and allow to cool at room temperature (not lower, however, than 70° F.) for one hour.

(*d*) Place the panel over an ⅛-in. rod, held firmly between suitable supports, at a point approximately midway between the upper and lower edges of the panel, and bend double *rapidly*. This bending should be done at a temperature not lower than 70° F. and if possible, not over 80° F.

The varnish to pass the test must show no cracking whatever at the point of bending. Cracking may be best discovered by observing the bent panel held closely at the proper angle under a shaded artificial light.

(*e*) A varnish which passes this 50-per-cent reduction test, may be said to possess an elasticity of *50 points*. One which will only stand a 25-per-cent reduction would be said to possess an elasticity of *25 points*.

Any varnish which is truly a "best-grade long oil Spar Varnish," as called for under the Signal Corps specifications, should pass the 50-per-cent reduction test outlined above without difficulty.

REPORTS AND SUGGESTIONS OF ANALYSTS.

Report of L. P. Nemzek.—We noted a few discrepancies in the preparation of the Kauri turpentine. The following are details noted:

1. Gum melted at 180° F.
2. 12 to 15 per cent distilled over between 180° and 385° F.
3. 11 to 15 per cent distilled over between 385° and 505° F.

Data:

Weight of receiver and distillate, g	138.5
Weight of receiver, g	39.7
Weight of distillate, g	98.8
Weight of Kauri, g	339.0
Per cent of distillate	29.9
Weight of residue, g	204.0
Per cent of residue	61.8

Complete solution of one part of the residual gum was effected in two parts of turpentine at a maximum temperature of 190° F., whereas the method states that a temperature of approximately 300° F. shall be used.

Note that 25 per cent by weight or more distilled over below a temperature of 505° F., whereas the method states that this amount should distill over around 700° F.

Report of G. C. Holton.—The Pulsifer test as applied in our laboratory appears to be a good test for indicating long oil varnishes. As a general proposition long oil varnishes are considered more durable than short oil varnishes, yet we have some varnishes which would be discredited by this test although they have a better endurance record than other varnishes that would pass the test.

Report of C. L. Sargent.—The elasticity test is both inaccurate and limited of application.

1. Three of the four varnishes that cracked under the bending test have stood the actual exposure test.

2. Varnishes must carry enough turpentine to hold up the Kauri solution and this must be better than 1 part of turps to 2 parts of petroleum.

3. Varnishes that have a tendency to frost must be baked in an electrical oven or one that is not heated by gas.

What the test actually shows is not the durability of the varnish out of doors but the ratio of the gum to oil, and it seems that 2.6 parts of oil to 1 part of gum is required, or 33 gallons of oil to 100 lb. of gum.

Report of M. Y. Seaton.—As a result of the tests, the indication is that there are as yet no varnish tests which will indicate the usefulness of the varnish for general purposes, or which will rapidly show its durability. Tests must be modified depending on the purpose for which the varnish is intended and if it satisfactorily meets such tests it must be considered a satisfactory varnish for the purpose, regardless of its composition or regardless of its behavior in tests not directly related to the use under consideration.

Report of James E. Heckel.—The only criticism which I can find of the method is that it did not show any difference whatever between the eight varnishes which passed the test, and therefore seemed merely to separate a brittle rosin benzine varnish from a great many other varnishes which possess various degrees of eleasticity, and which were all superior to the varnish which failed in the test.

It has not been possible to include all of the data obtained by the members, but a close study of their results indicates that the method is a very valuable contribution to the subject of varnish investigation. Although the criticisms above stated might indicate that the method has many shortcomings, they are offered only as constructive suggestions.

The above report has not been passed upon by the sub-committee and is only for the purpose of indicating a new line of thought. Therefore the sub-committee has no recommendations or suggestions to offer.

Respectfully submitted,

ALLEN ROGERS,
Chairman.

REPORT OF SUB-COMMITTEE XI ON PAINT THINNERS OTHER THAN TURPENTINE.

Sub-Committee XI has held no meeting since June, 1917, at Atlantic City, but has taken a letter ballot on the proposed Tentative Method for Determination of Flash Point of Paint Thinners other than Turpentine, appended to this report,[1] presented herewith, which it recommends for adoption as a tentative method.

Arrangements are being made with the Bureau of Standards to certify to the standardization of the Tag Closed Tester.

Respectfully submitted on behalf of the sub-committee,

CLOYD M. CHAPMAN,
Chairman.

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[1] See pp. 685–688.—ED.

REPORT OF SUB-COMMITTEE XIV ON THE PREPARATION OF IRON AND STEEL SURFACES FOR PAINTING.

Sub-Committee XIV presents the following progress report:

A meeting of the sub-committee was called for inspection of the test plates at Altoona, Pa., on Feb. 14, 1918, and at Brooklyn, N. Y., on the following day. Messrs. Cheeseman, McDonnell and Carpenter met and examined the test plates as noted.

At each location the plates were removed from the exposure frames on Feb. 11, 1918, and brought indoors for examination. They were returned to the frames on Feb. 18. In general the panels were still in such excellent condition and there were so few signs of incomplete protection of the surfaces that no conclusions as to the relative effects of the different surface conditions could be reached, and it was evident that a considerably further exposure would be required before the panels would give the indications necessary to permit such conclusions.

The only marked case of deterioration was that of the panels of Test No. 10, Schedule No. A-7. The description of these panels is given in the appended table showing the detailed record of inspection. Figs. 1 and 2 show the panels at Altoona on March 4, 1918, a few weeks after the inspection took place.

It was clearly established that the diagonal lines in test No. 10, along which lines of corrosion were found to be proceeding, were due to a process of straightening of the plates, which is known as "Patent Leveling." In this process the plates are stretched by placing them in tension through clamps applied on opposite edges. The effect of this process is clearly shown in Figs. 3 and 4, which are photographs of the opposite sides of an unpainted plate which was a part of one of the sheets from which the new steel plates for the tests were cut. This plate had been kept inside the Altoona Shop since the painting of the test panels and was photographed in April of this year. The photographs show the diagonal and other lines of stress very markedly, the effect having been to remove the mill scale on

these lines. Fig. 3 shows the side of the plate on which very little corrosion had obtained at the time of photographing. Fig. 4 shows the opposite side on which the corrosion had taken place along the lines of stress where the mill scale was removed. Except along the diagonal and other lines of stress, the mill scale was practically intact.

The detailed record of inspection of the panels is appended hereto.

Mr. A. H. Sabin, a member of the sub-committee, found an opportunity to examine the panels at Brooklyn, N. Y., on March 14, 1918, and he concurs in this report.

Respectfully submitted on behalf of the sub-committee,

A. W. CARPENTER,
Chairman.

APPENDIX.

REPORT OF INSPECTION OF TEST PANELS, FEBRUARY, 1918.

Series A.—Tests on New Steel.

Test No.	Schedule No.	Description.	Condition at Altoona on Feb. 14, 1918.	Condition at Brooklyn on Feb. 15, 1918.
1	A-1	Plates painted as received from mill; surfaces clean and free from rust, mill scale intact. Paint applied in warm, dry room.	Paint film in excellent condition with practically full protection of plate.	Paint film in very good condition. A limited number of very fine granular points or minute eruptions in paint film which might indicate incipient rusting beneath film.
2	A-2	Test surface rather badly abraded, about 25 per cent of mill scale gone, slightly rusted, also smeared with tallow. Washed with benzine, scraped and wire-brushed. Painted in warm room.	Excellent condition; practically the same as No. 1.	Diagonal sub-surface lines where mill scale was off and rusting had started before painting were very apparent. Paint film intact and generally same as No. 1.
3	A-3(1)	Surfaces sand-blasted and painted immediately thereafter in warm, dry room.	Excellent condition; practically the same as No. 1.	Paint film in excellent condition. Surface smooth except for pits in the steel surface developed by the sand-blast. Generally comparable with No. 1 with perhaps fewer granulations.

SERIES A.—(*Continued*)

Test No.	Schedule No.	Description.	Condition at Altoona on Feb. 14, 1918.	Condition at Brooklyn on Feb. 15, 1918.
4	A-3(2)	Surfaces sand-blasted and heated immediately thereafter in an oven to 225° F. Painted while still warm.	Paint film very good and apparently giving good protection, but numerous very fine granular points in film which might indicate incipient rusting.	Comparable with No. 1 with fewer incipient rust indications than Nos. 1 and 3.
5	A-3(3)	Surfaces sand-blasted and placed in cool damp room for 40 min. and painted therein. Temperature when painted 43–44° F.	Excellent condition; practically the same as No. 1. Some shriveling of film along the brush marks.	Paint film shows shriveling; otherwise condition generally the same as No. 1.
6	A-3(4)	Plates as received from mill; sand-blasted and placed out of doors and painted there. Temperature 25–27°F. Both coats dried outside.	Paint film shrivelled. General condition good. Fine eruptions or granulations disseminated over a considerable portion of the surface, showing possible incipient rusting under film. Abrasions of the film due to mechanical injury about 2½ in. from each short side.	Paint film shrivelled, very marked over several small areas. Fine, unbroken eruptions or granulations very general. Protection not quite so good as No. 1.
7	A-4	Sand-blasted and exposed out of doors for 7 days during which some rust developed which was not removed before painting. Painted in warm, dry room.	Similar to No. 1.	Film in excellent condition, better than No. 1.

SERIES A.—(*Continued*)

Test No.	Schedule No.	Description.	Condition at Altoona on Feb. 14, 1918.	Condition at Brooklyn on Feb. 15, 1918.
8	A-5	Pickled, rinsed in hot water neutralized with alkali solution and again washed. Painted in warm, dry room.	Similar to No. 1.	Slightly better than No. 1. Some rough spots in the steel under film.
9	A-6	Pickled as for No. 8 and exposed to weather for 7 days. Some rust developed which was not removed before painting. Painted in warm, dry room.	Similar to No. 1.	About the same as No. 1.
10	A-7	As received from mill were exposed to weather from Aug. 4, 1916 to Jan. 16, 1917, became deeply rusted, especially along diagonal lines. Some mill scale remained between diagonal lines. Surface cleaned with scraper and wire brush. Painted in warm, dry room.	Diagonal bands noted before painting were prominent in painted surface where the film was raised by rusting beneath. Rust was also progressing under film at other portions of the surface which were rusted before painting. (See Figs. 1 and 2.)	Diagonal bands were prominent. Rust was progressing under film where previously rusted, as indicated by raising of the film over areas of considerable magnitude and "pebbling" of film. Scaling started in a few spots.
11	...	Pickled and cleaned with cold water under pressure. Painted in warm, dry room.	Similar to No. 1.	Similar to No. 1; not quite so good.

SERIES A.—(*Continued*)

TEST No.	SCHEDULE No.	DESCRIPTION.	CONDITION AT ALTOONA ON FEB. 14, 1918.	CONDITION AT BROOKLYN ON FEB. 15, 1918.
16	...	Incompletely sandblasted. Painted in warm, dry room.	Similar to No. 1.	Similar to No. 1, but slightly better Painted surface so uniform over mill scale and cleaned areas that these could not be distinguished.

SERIES B.—TESTS ON OLD STEEL.

TEST No.	SCHEDULE No.	DESCRIPTION.	CONDITION AT ALTOONA ON FEB. 14, 1918.	CONDITION AT BROOKLYN ON FEB. 15, 1918.
12	B-1	About 25 per cent of surface bare and rusted; old paint on balance. Cleaned with wire brush only, leaving old paint on about 50 per cent of surface. Painted in warm, dry room.	Blisters forming in film over old paint in some places. General condition not so good as the other old panels but too early for definite conclusion.	Film surface rough due to sub-surface conditions. General condition good Some granulations in film indicating incipient rusting.
13	B-2	About 25 per cent of surface bare and rusted in spots, old paint on balance. Washed with benzine, scraped and wire-brushed leaving old paint on about 50 per cent of surface. Painted in warm, dry room.	Surface has a varied appearance due to differences in elevation of portions where old paint remained and was removed respectively before painting.	This plate had been badly indented before painting. Film in very good condition; with exception of a spot about 3 in. from one short side which appeared due to mechanical injury.

SERIES B.—(*Continued*)

Test No.	Schedule No.	Description.	Conditions at Altoona on Feb. 14, 1918.	Condition at Brooklyn on Feb. 15, 1918.
14	B-3	Approximately 10 per cent of surfaces bare and rusted in spots, old paint on balance. Brush-coated with benzine over and around rust spots and benzine burned off with torch flame. Surface then scraped and wire-brushed. Painted in warm, dry room.	In good condition. Film wrinkled over an area near the center of the numbered side. Most of the film surface is smooth.	Film rough over two-thirds of surface, with many wrinkles due to roughness of old, underlying paint coating. Coat intact and generally good except along a line about 3 in. from one short side which appeared due to mechanical injury.
15	B-4	Plates badly indented at several points, apparently by blows of a pick or other similar instrument. Approximately 50 per cent of surfaces bare and rusted. Sand-blasted in warm, dry room and painted therein about 3 hr. later.	Abrasions of film at apices of indentation evidently mechanical. Film has smooth surface except certain spots where plate was badly pitted before sand-blasting, where it had a granulated appearance due to the plate surface. Condition of film and protection, excellent.	One break in film at apex of an indentation, evidently mechanical. Surface of film generally smooth. Some portions show pitted under-surface. Condition of film and protection very good.

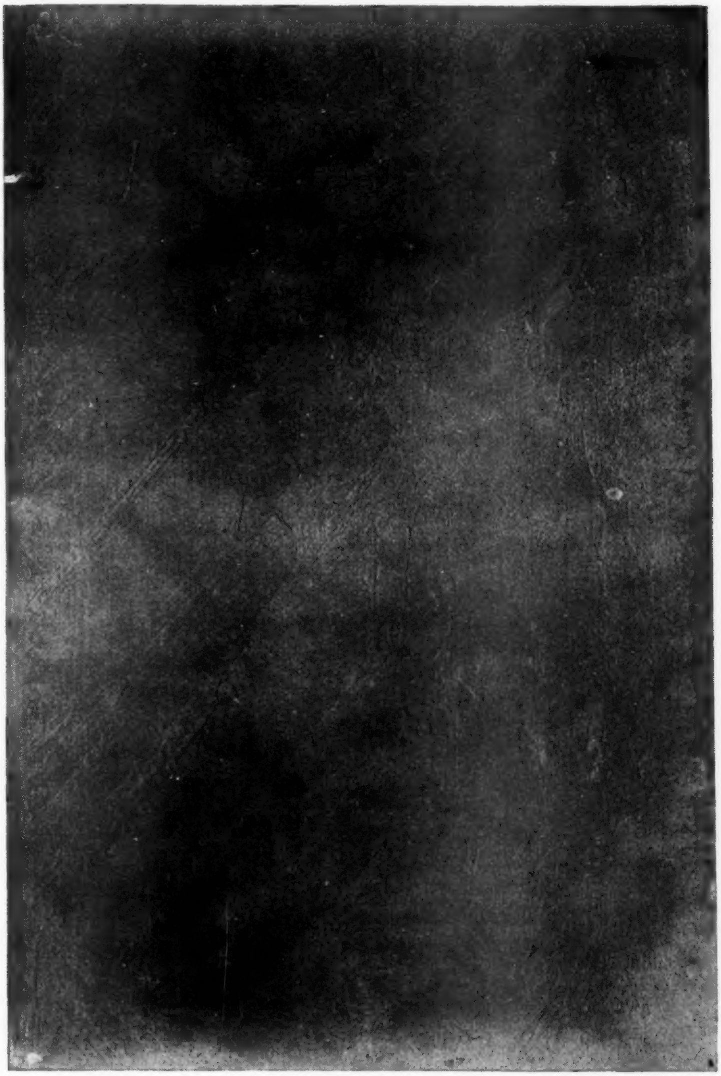

FIG. 1.—Entire Panel No. 10 (Schedule No. A-7) at Altoona, March 4, 1918.

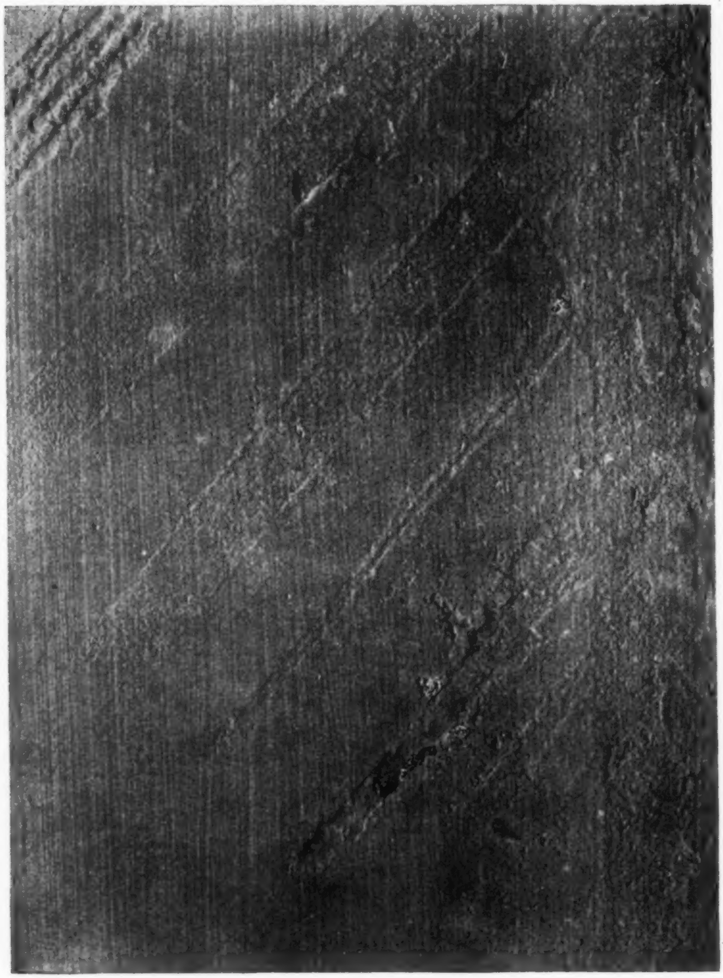

FIG. 2.—Portion of Panel No. 10, March 4, 1918 (about ¾ Size).

FIG. 3.—Diagonal-Stress Lines, Shown by Absence of Mill Scale, Along Which Very Little Corrosion has Taken Place.

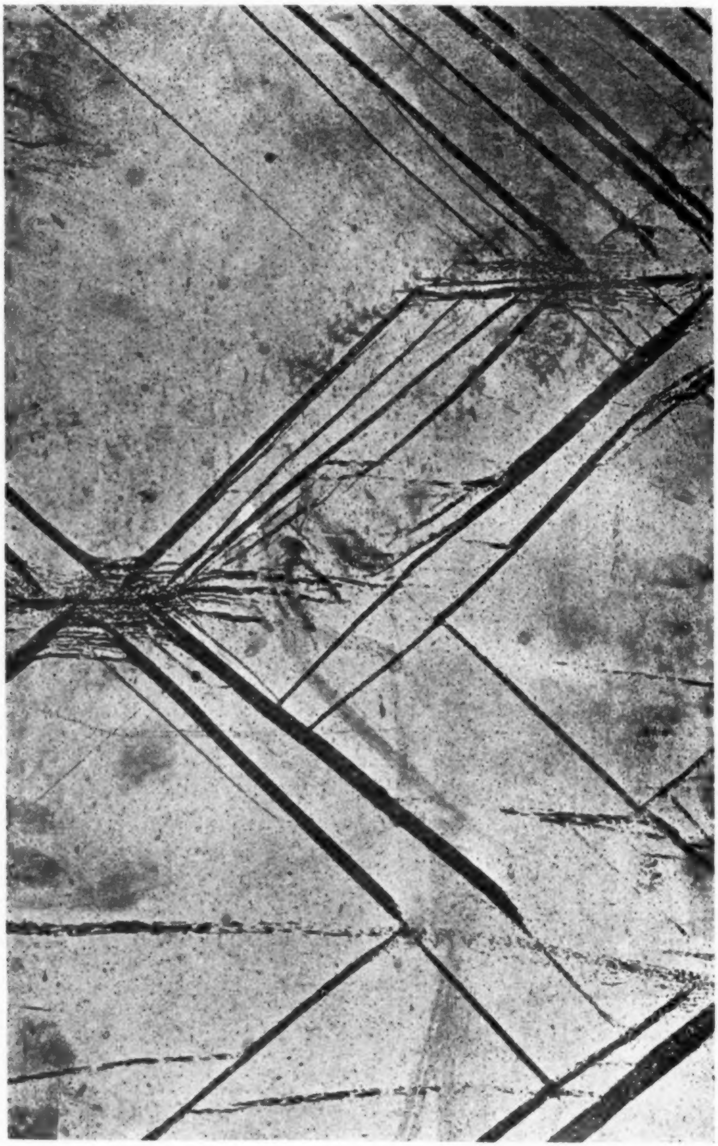

FIG. 4.—Diagonal Stress Lines, Shown by Absence of Mill Scale, Along Which Corrosion is Proceeding.

REPORT OF COMMITTEE D-2
ON
LUBRICANTS.

The committee has during the past year carried on further work on standard methods of tests for lubricants.

The committee feels that the need of an evaporation test for lubricating oils has not been demonstrated. In view of the results obtained, as shown in the report of the Sub-Committee on Evaporation Tests appended hereto, indicating that concordant results cannot be obtained unless certain conditions there enumerated are identical, no further work on evaporation will be done by the committee until the need of such a test is shown.

The committee respectfully recommends to the Society the adoption as standard of the following tests included in the Tentative Tests for Lubricants (D 47–17 T) presented last year and published in the Proceedings:[1]

Specific Gravity, revised to read as follows by the addition of the italicized words:

> Specific Gravity may be determined by hydrometer, Westphal balance, or pyknometer, providing these instruments are verified. The observation shall be taken with the sample at 15°.56 C. compared with water of the same temperature. *Correction for the buoyant effect of the atmosphere shall be made when necessary.*

Cloud and Pour Test for Petroleum Oils except Steam Cylinder and Black Oils;
Cold Test for Steam Cylinder and Black Oils;
Free Acid;
Carbon Residue.

The committee further recommends that "standard temperatures for viscosities" contained in the Tentative Tests submitted last year be withdrawn. In explanation of this recommendation, the committee believes that while eventually the adoption of these standard temperatures will be desirable, such adoption is not feasible at the present time. The use of the

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 767 (1917).

Fahrenheit temperatures 70°, 100°, 130° and 210° represent the common American practice. The committee's temperatures were approximate Centigrade temperatures approaching these as near as would be possible in round figures. At the present time, however, due to war conditions, not only has the use of the Fahrenheit temperatures greatly increased in this country, but these temperatures have also been adopted abroad—for instance, by the British government—and it is the feeling of the committee that an attempt to change the standard temperatures at the present time would result in confusion in the specifications for oils for the various governments and might tend seriously to delay matters looking toward the successful prosecution of the war. The committee anticipates that at a later date it will again present these temperatures for adoption as standard by the Society.

This report and the methods of test recommended by the committee to the Society for adoption as standard, have been submitted to letter ballot of the committee, which consists of 25 members; 23 ballots were returned, and 2 members refrained from voting. The following is the result of the ballot:

	Affirmative.	Negative.	Not Voting.
General Report	19	1	3
Method for Specific Gravity	20	1	2
Cloud and Pour Test for Petroleum Oils except Steam Cylinder and Black Oils	21	0	2
Cold Test for Steam Cylinder and Black Oils	19	2	2
Method for Free Acid	21	0	2
Method for Carbon Residue	21	0	2

Respectfully submitted on behalf of the committee,

C. P. VAN GUNDY,
Chairman.

K. G. MACKENZIE,
Secretary.

EDITORIAL NOTE.

The tentative tests referred to in this report were approved at the annual meeting in their proposed revised form and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

APPENDIX.

REPORT OF SUB-COMMITTEE ON EVAPORATION TESTS.

Since the last annual meeting of the Society, an extensive investigation has been conducted in the laboratory of the chairman of the Sub-Committee on Evaporation Tests to work out a satisfactory method and apparatus or air bath to get concordant results, one of the assistants in the laboratory spending most of his time on this work. I beg to advise that the results from this most exhaustive investigation are that unless the conditions as to air bath, method of heating the same, size and shape and materials of dishes used, method of placing dishes in the air bath and location of the thermometer bulbs, are

TABLE I.—OIL "A" AT 212° F. FOR 3 HOURS.

Amount of Oil, g.	Dish No.	Loss, per cent.	Average Loss, per cent.
5	1	0.15	
5	2	0.13	
5	3	0.16	0.14
5	4	0.12	
10	1	0.085	
10	2	0.085	
10	3	0.085	0.085
10	4	0.085	

TABLE II.—OIL "A" AT 250° F. FOR 3 HOURS.

Amount of Oil, g.	Dish No.	Loss, per cent.	Average Loss, per cent.
5	1	0.60	
5	2	0.56	
5	3	0.50	0.535
5	4	0.48	
10	1	0.28	
10	2	0.23	
10	3	0.27	0.264
10	4	0.275	

identical, concordant results will not be obtained at temperatures above 220° F. The results, briefly stated, are as follows:

1. The electrically heated air bath described in the Report

TABLE III.—OIL "A" AT 300° F. FOR 3 HOURS.

Amount of Oil, g.	Dish No.	Loss, per cent.	Average Loss, per cent.
5	3	3.26	
5	4	3.38	3.32
10	1	1.05	
10	2	0.98	
10	3	1.02	1.00
10	4	0.95	
10	1	0.91	
10	2	0.89	
10	3	0.93	0.91
10	4	0.92	

TABLE IV.—OIL "B" AT 300° F. FOR 3 HOURS.

Amount of Oil, g.	Dish No.	Loss, per cent.	Average Loss, per cent.
10	1	0.33	
10	2	0.31	
10	3	0.34	0.32
10	4	0.31	

TABLE V.—OIL "B" AT 400° F. FOR 3 HOURS.

Amount of Oil, g.	Dish No.	Loss, per cent.	Average Loss, per cent.
5	1	10.58	
5	2	10.08	
5	3	9.48	10.23
5	4	10.80	
5	1	10.42	
5	2	9.90	
5	3	10.30	10.16
5	4	10.04	
10	1	5.02	
10	2	4.91	
10	3	4.54	4.80
10	4	4.74	

of Committee D-2 last year under "Laboratory E"[1] was used, and desirable changes made from time to time in the heating elements, the perforated shelves, placing of solid plate above

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 464 (1917).

or below the perforated shelves, air vents, speed of revolving shelf, placing of dishes and thermometers, etc.

2. Four aluminum dishes were used throughout the work, dimensions and weight of these being closely as follows:

Square corners: inside diameter, 64 to 65 mm.; inside height, 18.5 to 19 mm.; thickness of metal, 1 to 1.5 mm.; weight, 14 to 15 g.

3. Amount of oil used in the various series: 5 and 10 g.

4. Temperatures used: 212, 250, 300 and 400° F.

5. The air bath was heated and regulated to the desired temperature and the dishes with the oil were quickly placed in position in the bath.

6. The duration of test was finally selected as three hours; at the expiration of this time the dishes were quickly removed while hot and placed in desiccators to cool.

7. While quite concordant results were obtained after working out the numerous details, changes and necessary precautions to be taken, as indicated in the accompanying Tables I to V, unless these details and precautions are rigidly followed it will be a difficult matter to get fairly concordant results by different laboratories.

Respectfully submitted,

P. H. CONRADSON,
Chairman, Sub-Committee III.

REPORT OF COMMITTEE D-4

ON

ROAD MATERIALS.

Committee D-4 herewith respectfully submits its report.

1. *Tentative Standards Recommended for Adoption Without Change.*—It is recommended that the following tentative standards be referred without change to letter ballot of the Society for adoption as standard:

(*a*) Tentative Test for Determination of Apparent Specific Gravity of Coarse Aggregates (D 30–17 T);[1]

(*b*) Tentative Form of Specifications for Certain Commercial Grades of Broken Stone (D 35–16 T);[2]

(*c*) Tentative Definitions of Terms Relating to Materials for Roads and Pavements (D 8–17 T).[3] These definitions cover the terms: Clinker, Mesh, Slag, Petroleum, Topped Petroleum, Rock Asphalt, Bituminous Emulsion, Viscosity, Penetration, Aggregate, Screen, Sieve, Bank Gravel.

2. *Amended Tentative Standard Recommended for Adoption.*—The Tentative Test for Toughness of Rock (D 3–17 T)[4] has been amended and a typographical error corrected. Both changes occur in the last sentence of Section 4, which it is recommended be changed to read as follows by the addition of the italicized words and the correction of 24 to 25:

> "After sawing, the ends of the specimens shall be ground plane with *water, and* carborundum or emery on a cast-iron lap until the cylinders are [24] *25* mm. in length."

It is recommended that this tentative test as revised be referred to letter ballot of the Society for adoption as standard.

3. *Tentative Revision of Standard Recommended for Adoption.*—It is recommended that the proposed Tentative Revision of the Standard Method for Distillation of Bituminous Materials

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 776 (1917).

[2] *Ibid.*, p. 810.

[3] *Ibid.*, p. 836.

[4] *Ibid.*, p. 773.

Suitable for Road Treatment (D 20-16), presented by the committee in its report last year[1] be referred to letter ballot of the Society for adoption as standard. For convenient reference this proposed revision is repeated in Appendix I to this report.

4. *Proposed Revision of Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregates Used in Cement Concrete (D 7-16).*[2]—During 1916 the U. S. Bureau of Standards called a conference of representatives of various scientific and technical societies, government bureaus, and private firms for the purpose of formulating and recommending for general adoption a standard screen scale for testing sieves. A member of Committee D-4 was designated to represent the committee at this conference, which finally adopted a scale as Standard. Committee D-4 then took under consideration the advisability of revising Standard Method D 7-16 so as to make it conform with the Standard adopted by the conference above mentioned. It was found that this would entail such slight modifications that the value of records already tabulated upon the basis of Standard Method D 7-16 would not be affected. Committee D-4, thereupon, informed the Bureau of Standards that it would recommend to the Society for adoption such portions of the conference standard as were applicable to road materials, provided the Bureau of Standards would eliminate the word "screen" from the title of its standard scale. This request was made in order to avoid conflict between the use of the word "screen" and the tentative definitions for "screen" and "sieve" recommended by the committee. The Bureau of Standards replied that in view of the facts presented it was "willing to make this modification in further publications of this scale, that is, to entitle it a 'Standard Scale for Testing Sieves'."

Committee D-4 considers it extremely undesirable that a proposed tentative revision of Standard Method D 7-16 be published for the prescribed period while the present standard remains. In view of the fact that the proposed revision is a distinct improvement, that its immediate adoption by the Society will be in the interest of general uniformity both in the

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII. Part I, p. 474 (1917).

[2] 1916 Book of A.S.T.M. Standards, p. 535.

manufacture and use of testing sieves, and that the Bureau of Standards has announced that it will test sieves of this series to determine whether they conform to specifications, Committee D-4 recommends that Standard Method D 7–16 be revised by substituting the table of sieve dimensions given in Appendix II of this report for the present table in the Method, and that the proposed revised standard be referred *this year* to letter ballot of the Society for adoption as standard.

5. *Proposed Tentative Tests for Determination of Apparent Specific Gravity of Sand, Stone and Slag Screenings and Other Fine Non-Bituminous Highway Materials.*—The Joint Conference Committee consisting of members of Committees C-9 and D-4 has during the past year considered various tests for determining the apparent specific gravity of sand, stone and slag screenings and other fine non-bituminous highway materials, and has proposed two alternate tests which are appended to this report under the above title.[1] It may be noted that one of these, the Le Chatelier test, is the same as the "Determination of Specific Gravity" adopted by the Society in the Standard Specifications and Tests for Portland Cement (C 9–17), except for slight modifications in wording to make it applicable to highway materials. The Jackson test is a very slight modification of the test described in the *Proceedings* of the American Society of Civil Engineers, December, 1917, pages 2379–2380. These tests have been accepted as alternates by Committee D-4 and are recommended for publication as tentative before referring them to letter ballot of the Society for adoption as standard.

6. *Tentative Method for Determination of Softening Point of Bituminous Materials other than Tar Products (D 36–16 T).*—It is recommended that this Tentative Method, published among the Tentative Standards last year,[2] be continued as tentative for another year. Criticisms received in connection with the specifications for the ball used in this test have been investigated and as a result it appears probable that the method should be slightly revised before recommending it for adoption as standard. It has been found that steel balls $\frac{3}{8}$ in. in diameter which are commercially available may not come within the limits of weight specified, and so far experiments have shown

[1] See pp. 689–693.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 811 (1917).

that test results are not materially affected by the ordinary variations in weight.

7. *Report of the Conference Committee of Committees C-9 and D-4.*—In addition to its recommendations relative to proposed Tentative Tests for Determining the Apparent Specific Gravity of Sand, Stone and Slag Screenings, and Other Fine Non-Bituminous Highway Materials, the Joint Conference Committee reports that it has under consideration methods proposed by Committee D-4 for the determination of the voids in mineral aggregates, as well as certain definitions. It has also under consideration the standardization of methods of sampling gravel, sand and similar materials.

8. *Conference Committee of Committees C-3 and D-4.*—No meeting of the recently appointed Conference Committee composed of three members from each of Committees C-3 on Brick and D-4 has as yet been called. It is hoped, however, that a meeting may be held in June at which time possible modifications of the present standard rattler test and new tests for paving brick will be given consideration.

The results of the letter ballot of the committee upon the recommendations which have been made affecting standards are as follows:

Recommendation.	Affirmative.	Negative.	Not Voting.
TENTATIVE STANDARDS RECOMMENDED FOR ADOPTION.			
Test for Determination of Apparent Specific Gravity of Coarse Aggregates (D 30-17 T)	29	1	13
Form of Specifications for Certain Commercial Grades of Broken Stone (D 35-16 T)	25	4	14
Definitions of Terms Relating to Materials for Roads and Pavements (D 8-17 T):			
Definition of Clinker	28	1	14
Definition of Mesh	28	1	14
Definition of Slag	28	1	14
Definition of Petroleum	25	1	17
Definition of Topped Petroleum	26	0	17
Definition of Rock Asphalt	27	0	16
Definition of Bituminous Emulsion	25	0	18
Definition of Viscosity	25	1	17
Definition of Penetration	26	0	17
Definition of Aggregate	28	1	14
Definition of Screen	29	1	13
Definition of Sieve	29	1	13
Definition of Bank Gravel	27	3	13

Recommendation.	Affirmative.	Negative.	Not Voting.
TENTATIVE STANDARDS RECOMMENDED FOR ADOPTION (*Continued*).			
Test for Toughness of Rock (D 3-17 T)—as amended........	30	0	13
PROPOSED REVISIONS IN EXISTING STANDARDS.			
Revision of Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment (D 20-16).........	25	0	18
Revision of Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregates Used in Cement Concrete (D 7-16).......	28	3	12
PROPOSED NEW TENTATIVE STANDARD.			
Tentative Tests for Determination of Apparent Specific Gravity of Sand, Stone and Slag Screenings and Other Fine Non-Bituminous Highway Materials.........................	28	1	14
TENTATIVE STANDARD TO BE CONTINUED.			
Tentative Method for Determination of Softening Point of Bituminous Materials other than Tar Products (D 36-16 T)....	19	3	21

This report has been submitted to letter ballot of the committee, which consists of 43 members, of whom 27 have voted affirmatively, none negatively, and 16 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. W. PAGE,
Chairman.

PRÉVOST HUBBARD,
Secretary.

EDITORIAL NOTE.

The proposed revisions in the two standards referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on August, 26 1918. The standards as thus revised appear in the 1918 Book of A.S.T.M. Standards.

The four tentative standards referred to in the report were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The Tentative Method for Determination of Softening Point of Bituminous Materials other than Tar Products was continued as tentative and appears on pages 707–708.

The proposed new tentative tests referred to in the report were accepted for publication as tentative and appear on pages 689–693.

APPENDIX I.

PROPOSED REVISION

IN THE

STANDARD METHOD FOR DISTILLATION OF BITUMINOUS MATERIALS SUITABLE FOR ROAD TREATMENT (D 20-16).

The following revision in the Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment (D 20-16),[1] proposed by Committee D-4 last year,[2] is recommended for adoption as standard:

Strike out the present Section 3 (*b*) and insert the following:

"*Thermometer.*—The thermometer shall conform to the following requirements:

"It shall be made of thermometric glass of a quality equivalent to suitable grades of Jena or Corning make. It shall be thoroughly annealed. It shall be filled above the mercury with inert gas which will not act chemically on or contaminate the mercury. The pressure of the gas shall be sufficient to prevent separation of the mercury column at all temperatures of the scale. There shall be a reservoir above the final graduation large enough so that the pressure will not become excessive at the highest temperature. The thermometer shall be finished at the top with a small glass ring or button suitable for attaching a tag. Each thermometer shall have for identification the maker's name, a serial number, and the letters 'A.S.T.M. Distillation.'

"The thermometer shall be graduated from 0 to 400° C. at intervals of 1° C. Every fifth graduation shall be longer than the intermediate ones, and every tenth graduation

[1] 1916 Book of A.S.T.M. Standards, p. 540.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 474 (1917).

beginning at zero shall be numbered. The graduation marks and numbers shall be clear-cut and distinct.

"The thermometer shall conform to the following dimensions:

Total length, maximum......	385 mm.	
Diameter of stem...........	7 "	; permissible variation, 0.5 mm.
Diameter of bulb, minimum..	5 "	; and shall not exceed diameter of stem.
Length of bulb.............	12.5 "	permissible variation, 2.5 mm.
Distance from 0° to bottom of bulb..................	30 "	; " " 2.5 "
Distance from 0° to 400°.....	295 "	; " " 10 "

"The accuracy of the thermometer when delivered to the purchaser shall be such that when tested at full immersion the maximum error from 0 to 200° C. shall not exceed the following:

From 0 to 200° C..........................	0°.5 C.
" 200 " 300° C..........................	1°.0 C.
" 300 " 375° C..........................	1°.5 C.

"The sensitiveness of the thermometer shall be such that when cooled to a temperature of 74° C. below the boiling point of water at the barometric pressure, at the time of test, and plunged into free flow of steam, the meniscus shall pass the point 10° C. below the boiling point of water in not more than 6 seconds.

"The thermometer shall be set up as for the distillation test, using water, naphthalene and benzophenone as distilling liquids. The correctness of the thermometer shall be checked at 0 and 100° C. after each third distillation until seasoned."

APPENDIX II.

PROPOSED REVISION

IN THE

STANDARD METHOD FOR MAKING A MECHANICAL ANALYSIS OF SAND OR OTHER FINE HIGHWAY MATERIAL, EXCEPT FOR FINE AGGREGATES USED IN CEMENT CONCRETE (D 7–16).[1]

Strike out the present table after the first paragraph, namely:

Meshes per Linear Inch (=2.54 cm.).	Diameter of Wire, in.	Diameter of Wire, mm.
10	0.027	0.6358
20	0.0165	0.4191
30	0.01375	0.34925
40	0.01025	0.26035
50	0.009	0.22865
80	0.00575	0.1460
100	0.0045	0.1143
200	0.00235	0.05969

and insert the following table:

Mesh Designation.	Unit of Measure.	Actual Mesh.	Opening.	Wire Diameter.	Permissible Variations.	
					Mesh.	Diameter.
10	cm	3.9	0.200	0.056	± 0.04	± 0.005
	in	9.9	0.079	0.022	± 0.1	± 0.002
20	cm	8	0.085	0.040	± 0.2	± 0.0015
	in	20.3	0.0335	0.0157	± 0.5	± 0.0006
30	cm	12.0	0.050	0.033	± 0.4	± 0.0012
	in	30.5	0.0197	0.0130	± 1.0	± 0.0005
40	cm	16	0.036	0.026	± 0.6	± 0.0010
	in	40.6	0.0142	0.0102	± 1.5	± 0.0004
50	cm	20	0.029	0.021	± 0.8	± 0.0010
	in	50.8	0.0114	0.0083	± 2	± 0.0004
80	cm	31	0.017	0.015	± 1	± 0.0008
	in	78.7	0.0067	0.0059	± 3	± 0.0003
100	cm	39	0.014	0.0116	± 1	± 0.0008
	in	99.1	0.0055	0.0046	± 3	± 0.0003
200	cm	79	0.0074	0.0053	± 3	± 0.0005
	in	200.7	0.0029	0.0021	± 8	± 0.0002

[1] See 1916 Book of A.S.T.M. Standards, p. 535.

REPORT OF COMMITTEE D-5

ON

COAL.

Since the development of the Standard Method for the Sampling of Coal prepared by the committee, which was adopted by the Society and printed in the 1916 Book of A.S.T.M. Standards, no material progress has been made in the further development of standard specifications for the reason that the purchase of coal under specifications has been in a continued state of evolution and development, and also that, as a result of the war, matters relating to the purchase of coal have been so abnormal and unsettled.

An expression of opinion has been obtained from the members of the committee concerning its present as well as its future activities, and the sentiment expressed is that the committee should be kept in existence even though there is no active work immediately in view; and although the committee is forced to be inactive at the present time because of the rapidly changing conditions in the coal industry, that fact should argue for the continuance of the committee, for thereby there would be immediately available. for any action that might be deemed wise after conditions become normal, the knowledge that the committee had acquired in its past work and the benefit of the experience had by its different members in their close relation to fuel progress, and there would be no lost motion in creating and organizing another committee.

Accordingly, the committee respectfully requests its continuance.

Respectfully submitted,

George S. Pope,
Chairman.

Editorial Note.

The above report of Committee D-5 was originally presented to the Executive Committee, who presented it at the annual meeting and recommended its publication in the Proceedings as a report of progress.

REPORT OF COMMITTEE D-6
ON
COKE.

Committee D-6 begs to report that the Tentative Methods for Laboratory Sampling and Analysis of Coke (D 37–16 T), submitted in 1916 and continued as tentative last year,[1] have been subject to trial and criticism since that time. It has been suggested that on account of American porcelain ware now being available, all reference to foreign brands of porcelain be omitted. No other objections having been presented, the provisions of the methods in question being considered fair and fully in accord with the present state of the art, your committee recommends that these methods be revised as indicated below, and referred to letter ballot. In the following revisions the page numbers refer to *Proceedings*, Vol. XVII, Part I (1917):

> Page 816, lines 5 and 6; page 817, lines 19 and 20; page 821, line 3; delete the words "Royal Meissen." Page 821, line 7, delete the words "Royal Berlin."
>
> Page 822, lines 1 and 2, change "Transfer to a No. 1 Royal Meissen porcelain capsule, 1 in. deep and 2 in. in diameter, or a No. 1 Royal Berlin crucible," to "Transfer to a No. 1 porcelain capsule, 1 in. deep and 2 in. in diameter, or a No. 1 porcelain crucible."

This report has been submitted to letter ballot of the committee, which consists of 16 members, of whom 12 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

A. C. FIELDNER,
Secretary.

EDITORIAL NOTE.

The tentative methods referred to in this report were approved at the annual meeting in their proposed revised form and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 813 (1917).

REPORT OF COMMITTEE D-7
ON
TIMBER.

The report of the committee is presented in two parts, devoted respectively to the work of two of its sub-committees on the subjects of (1) wooden paving blocks and (2) timber preservatives. The reports of the sub-committees to the main committee are presented in practically the same form as originally submitted, followed by the recommendations of the committee with respect to matters affecting standards, together with the letter ballot of the committee on such recommendations.

Sub-Committee IV on Wooden Paving Blocks.

Sub-Committee IV herewith submits its report on wooden paving blocks.

The sub-committee gave the subject of wooden paving blocks considerable attention in 1916, with a view of getting specifications that would be satisfactory to all parties concerned, both producers and users. With this end in view, the chairman of the sub-committee called an informal meeting of members of committees on wood pavements from the different societies considering the subject, and representatives of the following met in Brooklyn on September 12, 1915, and considered the subject in great detail:

- American Society of Civil Engineers;
- American Society of Municipal Improvements;
- American Railway Engineering Association;
- Southern Pine Association;
- American Wood Preservers' Association (Committee on Wood Blocks, and also the Committee on Preservatives);
- American Society for Testing Materials.

As will be seen, these representatives were from practically every society or organization in the country interested in the movement. The specifications were considered in great detail, and every phase of them discussed. It was recognized by everyone that it would be of great importance if specifications could be adopted that would be satisfactory to all interests, and it was also felt that possibly by waiving a small requirement here and another there this might be accomplished. After considerable discussion, specifications were unanimously adopted, there being fourteen individuals representing the different societies.

Since that time these specifications were adopted at the meeting of the American Society of Municipal Improvements, held in Newark, N. J., in October, 1916.

Subsequent to the September meeting, however, a patent was issued covering the treatment of wood paving blocks which might be infringed upon if the treatment suggested in the specifications was entirely carried out. The treatment in question, quoted from the specifications as originally written, is as follows:

> "After this a supplemental vacuum, in which the maximum intensity reached is at least 20 in. and the time the vacuum is applied not less than 30 minutes, shall be applied. If desired, this vacuum may be either preceded or followed by a short steaming period."

This was known prior to the meeting of the American Wood Preservers' Association which was held in New York City in January, 1917, and that clause was modified by leaving out the words "either preceded or," as it was thought that by so doing there would be no infringement on the patent referred to.

The sub-committee, therefore, presented for the action of the main committee the specifications adopted at the meeting held in Brooklyn in September, 1915, as modified by the Wood Preservers' Association in January, 1917, and as modified by the main committee by changing the specific gravity of the fraction between 235 and 315° from 1.02 to 1.03 for both kinds of coal-gas tar oils, and the same change for the specific gravity of the total distillate below 355° C. for water-gas tar.

While the specifications submitted provide for a preservative that is a product of coal-tar oil exclusively, the sub-committee

recognizes that many engineers feel that equally good results can be obtained from a preservative manufactured from water-gas tar and that many pavements have been laid treated with that material. The sub-committee, therefore, submits for information a specification for a preservative manufactured from water-gas tar, should anyone desire to use it. It might be said also that this same action was taken by the American Wood Preservers' Association.

It is understood by the sub-committee that all tests and analyses will be made according to the Methods for Sampling and Analysis of Creosote Oil submitted by Sub-Committee VI on Preservatives.

Committee D-7 endorses the action of its sub-committee, and recommends that the proposed Specifications for Wooden Paving Blocks, appended hereto,[1] be published among the Tentative Standards of the Society. The vote by letter ballot of the committee on this recommendation is as follows: Affirmative, 28; negative, 2; not voting, 4.

SUB-COMMITTEE VI ON TIMBER PRESERVATIVES.

In pursuance of the recommendation of its Sub-Committee on Preservatives, the committee recommends that the Tentative Methods for Analysis of Creosote Oil (D 38 – 17 T),[2] comprising methods for the Float Test of Residue and Coke Residue, be referred to letter ballot of the Society for adoption as standard, to be incorporated, if adopted, in the Standard Methods for Sampling and Analysis of Creosote Oil (D 38–17).

The vote by letter ballot of the committee on this recommendation is as follows: Affirmative, 30; negative 1; not voting, 3.

The committee recommends that the following three tentative specifications[3] be continued as tentative:

Tentative Specifications for Selected Structural Douglas Fir Bridge and Trestle Timbers (D 23–16 T);

Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted (D 24–15 T);

[1] See pp. 625–629.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 826 (1917).

[3] *Ibid.*, pp. 704–711.

Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted (D 25–15 T).

This report has been submitted to letter ballot of the committee, which consists of 34 members, of whom 27 have voted affirmatively, 2 negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

HERMANN VON SCHRENK,
Chairman.

EDITORIAL NOTE.

The proposed Tentative Specifications for Wooden Paving Blocks referred to in this report were accepted for publication as tentative and appear on pages 625–629.

The Tentative Methods for Analysis of Creosote Oil referred to in the report were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The three tentative specifications referred to in the report were continued as tentative and appear on pages 617–624.

For Discussion of this report, see page 340.

DISCUSSION.

Mr. von Schrenk.

MR. HERMANN VON SCHRENK (*Chairman of Committee D-7*).—In presenting the proposed Tentative Specifications for Wooden Paving Blocks, I wish to call attention to one or two slight corrections. First, the references in the report as well as in the specifications to "water-gas tar oil," should be changed to "water-gas tar."

Second, it is suggested that a slight addition be made to the title of the specifications. These specifications are intended to apply to "exposed pavements" as distinguished from pavements to be used under cover, frequently called interior wood block. It is accordingly suggested that the words "for exposed pavements" be added to the title, which will then read: "Proposed Tentative Specifications for Wooden Paving Blocks for Exposed Pavements." In order that this may be perfectly clear, it is suggested that a clause be added to the specifications, reading:

> "These specifications cover wooden paving blocks for pavements exposed to alternate wet and dry conditions, as distinguished from pavements which are used under cover and protected from atmospheric influences."

I move, therefore, that the proposed Tentative Specifications for Wooden Paving Blocks for Exposed Pavements as thus revised, be accepted for publication as tentative. [Motion seconded.]

Mr. Forrest.

MR. C. N. FORREST (*presented in written form*).—The writer has been associated with the creosoted wooden paving block industry for the past twelve years on account of his connection with a large company consuming preservative oils in creosoting, as well as the general treatment of timber.

About ten years ago a low-carbon coke-oven tar was introduced as a substitute for creosote distillate in the wood-block industry, and the present specifications for coal-tar paving oil, recommended by Committee D-7, are merely a modification of those which have been promoted by a certain manufacturing

interest since that time in an endeavor to monopolize the market for that type of preservative. **Mr. Forrest.**

Specifications similar to those now presented by Committee D-7 have also been presented in turn to the American Society for Municipal Improvements, the American Society of Civil Engineers, the American Wood Preservers' Association and others, as mentioned in this report, but the specifications were not accepted or adopted by these other societies until they had been amended by adding to the list of acceptable preservatives, and, on a parity therewith, a third preservative: water-gas tar.

A specification for water-gas tar has been presented by Committee D-7 simply "as information." Refined water-gas tar as a preservative for wooden paving blocks has been in successful use for the past ten years or for a period of time fully as long as that in which the coal-tar paving oil has been in service. A very complete record of service of water-gas tar-treated paving blocks was presented by a special committee upon that subject to the American Wood Preservers' Association in January, 1917, and it was as a result of the authentic data furnished by that committee that that Association included water-gas tar as one of three preservatives in the specifications it adopted for wooden paving blocks and published in its manual.

It is in order at this time to refer the specifications back to the committee for reconsideration, or with instructions to bring in amended specifications which will include water-gas tar as a preservative and on a parity with one or more other preservatives. The writer urges that that be done on the grounds that the plea of the committee for uniformity of the specifications of this Society with those of others similarly interested will not be accomplished unless water-gas tar is included in the specifications, and that the adoption of but the one type of coal-tar paving oil will place the consumers of that commodity at the mercy of one producing interest.

Mr. W. H. Fulweiler.—I wish to discuss more particularly that part of the specifications relating to "Preservatives." In the first place, I believe that these are not specifications, but merely descriptions; secondly, that they are purely commercial in their significance; and thirdly, they are old, having been published by other societies that have made it a business for **Mr. Fulweiler.**

Mr. Fulweiler. years to follow the variations in commercial requirements for such materials. Since they bring nothing new, make no advance in the arts, and are unsupported by any data of tests or performance, I feel that the Society would be ill advised in accepting them.

The sections relating to preservative are not really specifications in the sense that this Society has heretofore recognized the word; they are merely descriptions, and rather loose ones, of certain grades of commercial products that can only be prepared from coke-oven tar, the supply of which, at least in the East, is practically controlled by one company. The use of the word "coal tar" is therefore a misnomer, and the adjective "coke oven" would more correctly describe the material, since coal tar obtained in the usual method of the manufacture of gas in the horizontal retort or that prepared in the carbonization of coal in the vertical retort, will not commercially produce a material that will conform to the requirements of these specifications.

A moment's thought will show that no attempt has been made to insure that the material will possess any of the characteristics that would make it suitable for a preservative. If it is argued that the art has not advanced to such a point that this is possible, then the Society is not justified in adopting so-called specifications that are admittedly only imperfect descriptions. For many years it was argued that water-gas tar, since it contained no tar acids, could not have the toxic elements necessary for a wood preservative. We find no mention, however, of a test for tar acids or bases. In the endeavor to exclude the addition of water-gas tar, use was made of the specific gravity of the fractions distilling between 235 to 315° C. and 315 to 335° C. The limits chosen are such that, as before mentioned, the distillates and mixtures made from the tars produced in the manufacture of illuminating gas by the distillation of coke in horizontal and vertical retorts, which is the usual method of manufacture, are practically excluded. The results published by the committee of the American Wood Preservers' Association[1] show that even going to this length, from 15 to 20 per cent of water-gas tar could still be added. I think it is

[1] *Proceedings*, Am. Wood Preservers' Assoc., 1917, pp. 353 and 359.

evident, therefore, that these so-called specifications are inherently defective and that this method of preventing the admixture of water-gas tar should be abandoned. In view of the present shortage and difficulty in obtaining creosote oils, it would appear to have been a far wiser policy on the part of the committee to have brought in some constructive work that would have led to an increase in the supply of suitable oils, rather than to have attempted to limit the supply of available materials. **Mr. Fulweiler.**

In closing, I would move as an amendment to the motion, that Sections 7 to 9 on "Preservatives" be eliminated from the proposed tentative specifications, and referred back to the committee, with instructions to bring forward a more scientific form of specification that will cover all of the available preserving oils suitable for wooden paving blocks, instead of confining their efforts to one class. [Amendment seconded.]

Mr. von Schrenk.—These specifications have resulted after discussions during seven or eight years, which finally culminated in the general meeting, under the leadership of Mr. George W. Tillson, at which the committees of various engineering societies of the country agreed on specifications. The objections made against the specifications by Mr. Forrest and Mr. Fulweiler have all been considered very fully. These are the best specifications which the committee has been able to formulate after advising with all those whom the committee could reach and who are supposed to know about such matters, including the officials of the United States Forest Service. The chairman has no hesitation in saying that while the specifications may not be perfect, they are the best that can be developed at the present time. The committee will of course be glad to consider constructive criticism during the coming year. In view of the fact that this is now the second time that this report has been presented in practically its present form, I doubt very much whether it would serve any good purpose to refer the report back to the committee. Its rejection last year was due entirely to a technicality, and in spite of much work done during the present year the committee has been unable to materially change the specifications as presented last year. We, therefore, ask you to accept them as presented in the light of the best knowledge of the best men the committee could find. **Mr. von Schrenk.**

Mr. Church.

MR. S. R. CHURCH.—I will supplement the chairman's remarks by a few words on the origin of the specifications for preservatives which Mr. Fulweiler has criticised rather severely. I was chairman of the sub-committee of the Committee on Preservatives of the American Wood Preservers' Association which drew up these specifications. Mr. Fulweiler was a member of the committee and two representatives of the U. S. Department of Agriculture were also members of the committee; and it was largely due to recommendations by the members from the Forest Products Laboratory and Mr. Fulweiler himself, that the clauses to which he now refers as having a monopolistic tendency were made a little more restrictive than the committee had originally intended, in an endeavor to maintain the specifications for a coal-tar product, and to eliminate, so far as we knew how to do so, the possible adulteration of the oil with products obtained from water-gas tar or other petroleum sources. The statement made by Mr. Fulweiler that the specifications limit the oil to a product derived from coke-oven tar and eliminate the use of oil obtained from gas-works tar is, in my opinion, inaccurate.

Mr. Fulweiler.

MR. FULWEILER.—Mr. von Schrenk and Mr. Church have touched upon the history of these specifications. I am not a member of the sub-committee which prepared the specifications which have been submitted to this Society. I was a member of the committee that prepared similar specifications for the American Wood Preservers' Association, and as such they are perfectly proper for that association, because that association expects to change its specifications with the commercial demands for material. I do not think, however, that this Society is in precisely that condition. This Society should stand for specifications that represent some advance in the art. There is no clause in the proposed specifications that attempts to secure any quality required in the wood-preserving material. As I see it, it might broadly be outlined that, first of all, the preservative material must penetrate the wood; secondly, that it should remain in the wood, that is, should not evaporate out; and thirdly, that it should have some preservative value, be that toxicity or waterproofing. Now there is absolutely nothing in these specifications that requires such things. They are purely

and simply descriptions. While it is perfectly proper for certain societies to have such specifications, I think it is not right for this Society to follow their lead. I feel that the committee would be better advised to do some constructive work, rather than ask this Society to accept the work of some other society unsupported by any data that have been presented to this Society. **Mr. Fulweiler.**

MR. C. M. TAYLOR.—As a consuming member of Committee D-7, I should like to state that, so far as I can see in my experience on this subject, we would do well to accept these specifications as tentative for this year. We are not adopting them as a permanent standard, and if the need for changes should develop during the next year there is opportunity afforded for revision. The specifications are not perfect, but for the uses to which they are to be put, they are entirely satisfactory. **Mr. Taylor.**

MR. VON SCHRENK.—The whole problem seems to resolve itself into the question of whether the committee is right in recommending to the members of this Society that they use a certain kind of preservative oil. With the exception of two members who are personally interested in the use of water-gas tar, the committee is unanimous in its opinion, both producers and users. We have not yet seen any better description of the preservative oil, and if Mr. Fulweiler knows of a better description, the committee should like to know of it. **Mr. von Schrenk.**

The committee is unwilling to endorse the use of water-gas tar at the present time as a preservative, for the reason that we have been unable to find, all contradiction notwithstanding, any definite record of its profitable and equitable use for a long period of time which would warrant the committee in recommending it as a definite standard. Water-gas tar has been mixed for years with coal-tar oil in such a manner that there are no definite records of how it was mixed or what the results are. Therefore, the committee recommends that the Society accept the specifications as presented. The commercial considerations, while having something to do with the subject, have nothing to do with the technical value of the specifications.

[Mr. Fulweiler's amendment was then put to a vote and lost.]

Mr. Talbot.

MR. A. N. TALBOT.—To avoid any misunderstanding in the future, will the Chair rule whether, upon the adoption of the original motion, the appendix at the end of the specifications, covering water-gas tar, will be printed in the tentative standards or not?

Mr. Stevenson.

MR. A. A. STEVENSON.—It seems to me that this might be taken care of in a very simple way. Instead of calling it an Appendix, do as we have done in other specifications—call it a Note. I think this would cover the whole question, and to place it properly before the meeting I move as an amendment to Mr. von Schrenk's motion that the appendix to the specifications, relating to water-gas tar, be printed with the specifications in the form of a note. [Amendment seconded, and accepted by Mr. von Schrenk.]

Mr. Chapman.

MR. CLOYD M. CHAPMAN.—I think that is a very good suggestion. There may be other classes of preservatives which can be added from time to time as information in the form of notes at the end of these specifications, giving the purchaser the option of specifying any preservative he chooses.

[The motion as amended was then carried.]

REPORT OF COMMITTEE D-8

ON

WATERPROOFING.

In its annual report last year, Committee D-8 presented specifications for certain materials for damp-proofing and waterproofing, which were accepted by the Society as tentative with slight modifications in the titles, and published among the Tentative Standards of the Society[1] under the following titles:

Tentative Specifications for Asphalt for Use in Damp-proofing and Waterproofing (D 40–17 T);

Tentative Specifications for Primer for Use with Asphalt for Use in Damp-proofing and Waterproofing (D 41–17 T);

Tentative Specifications for Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 42–17 T);

Tentative Specifications for Creosote Oil for Priming Coat with Coal-Tar Pitch for Use in Damp-proofing and Waterproofing (D 43–17 T).

In the report it was announced that because of the then present conditions, arising from the state of war in which our country is involved, no conclusive work in the matter of conveying media, saturated felts and woven fabrics had been accomplished. Mention was also made of certain market conditions militating against the preparation of specifications covering media.

Recognizing the urgent need of additional specifications and anticipating, in a measure, that owing to war conditions urgent duties of its members might divert their energies from the solution of the problems before the committee, it was hoped that during the year additional specifications might be drafted and presented. While Committee D-8 recognizes the importance of the work of the Society and realizes its reliance upon the committees for constructive work within reasonable periods, it is unable, at this time, to present additional specifications.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 712–722 (1917).

The present tentative specifications under the headings and serial designations above enumerated are incomplete in that they do not cover the media, such as saturated felts and woven fabrics, which must be used with the bituminous compounds in waterproofing. The committee therefore recommends that these specifications be continued as tentative without revision, pending their completion by the addition of standards for waterproofing media.

This report has been submitted to letter ballot of the committee, which consists of 24 members, of whom 19 have voted affirmatively, none negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. W. WALTER,
Acting Chairman.

LEROY M. LAW,
Secretary.

EDITORIAL NOTE.

The four tentative specifications referred to in this report were continued as tentative and appear on pages 630–640.

REPORT OF COMMITTEE D-9
ON
ELECTRICAL INSULATING MATERIALS.

Committee D-9 submits the following as its report for the year:

One meeting of the committee was held, at which it was decided to ask that the Tentative Tests for Molded Insulating Materials (D 48–17 T), submitted last year,[1] be continued as tentative for the present because there are certain additions that the committee desires to work out before having these tests finally adopted by the Society.

Sub-Committee III on Tests of Liquid Insulation reported that an elaborate series of tests had been prepared and were being worked out in four different laboratories but were not yet in form for presentation.

Sub-Committee V presented a specification for the testing of insulating varnishes, which was considered at length and finally referred back to the sub-committee for certain modifications. These have been made by the sub-committee, in line with the suggestions, but it has not been possible to get a further meeting of the main committee in time to get this specification before the Society for adoption as a tentative standard this year. This suggested specification will therefore be given as thorough a trial this year as possible by the members of the committee and others who may be interested, with the expectation of presenting it for adoption as a tentative specification next year.

This report has been submitted to letter ballot of the committee, which consists of 15 members, of whom 11 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

C. E. Skinner,
Chairman.

Editorial Note.

The tentative tests referred to in this report were continued as tentative and appear on pages 694–706.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 778 (1917).

REPORT OF COMMITTEE D-10
ON
SHIPPING CONTAINERS.

National conditions arising from the state of war in which this country is involved, have prevented active continuation of investigations necessary in preparing specifications for shipping containers.

Two specifications were submitted at the last annual meeting, and accepted for publication among the tentative standards of the Society, namely: Tentative Specifications for Canned Foods Boxes, Nailed and Lock-Corner Construction (D 44–17 T), and Tentative Specifications for Canned Foods Boxes, Wirebound Construction (D 45–17 T).[1] The committee respectfully recommends that these two tentative specifications be continued as tentative for another year.

This report has been submitted to letter ballot of the committee, which consists of 28 members, of whom 17 have voted affirmatively, none negatively, and 11 have refrained from voting.

Respectfully submitted on behalf of the committee,

B. W. Dunn,
Chairman.

W. S. Topping,
Secretary.

Editorial Note.

The two tentative specifications referred to in this report were continued as tentative and appear on pages 641–649.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 723–731 (1917).

DISCUSSION.

Mr. J. C. Nellis.—I should like to state briefly, not in direct connection with this report, but on the general matter of box testing, that in the past twelve months there have been developments in box testing and the formulation of specifications which have carried us much further than have the specifications presented to this Society. The war is responsible for this development. The testing heretofore reported to the Society has been done by the Forest Products Laboratory, which has expanded its testing work, especially in cooperation with the Ordnance Department. The Ordnance Department is having all its boxes tested and the results of the tests show in the Specifications for Ordnance Box. A great many of the boxes going over seas are designed by the results of those tests. Mr. Nellis.

But the work has gone further than the Ordnance Department. As most of you know from the newspapers, the War Department, as a whole, has been forced to undertake a program of space-saving in cargo ships. In the matter of containers this has developed in two ways. First of all they have worked to design containers that would save displacement, and much has been done in that line. Secondly, they have worked to do away with containers and use baling. Uniforms and blankets may be compressed in a bale and boxing done away with entirely. That has saved considerable space. The War Department, to handle this and other work, has established a Bureau of Industrial Research under General Goethals, Director of Purchases, Storage and Traffic. This Bureau is in charge of Dr. Hammerschlag, formerly Director of the Carnegie Institute at Pittsburgh.

A committee consisting of the Forest Products Laboratory box-testing man and the packing experts of the General Electric Co. and the International Harvester Co. has very recently drawn up general box and crate specifications for the War Department, which are general in character and have been issued as guiding specifications for the different corps. The

Mr. Nellis. different corps are issuing their own particular specifications. The Quartermaster's Corps, for instance, has issued specifications for canned-goods boxes which, by the way, are very similar to those submitted to the Society, although they are designed particularly for export. The General Engineer Depot will shortly issue crating specifications for packing material weighing up to a couple of tons. The Signal Corps has its own problems, etc. The general situation, so far as the formulation of box specifications and progress in testing is concerned, is really pretty satisfactory. Things of course are coming with a rush simply because of the need of getting material over seas without any breakage either in transportation on this side, on the docks, or on the other side. Because there has been more or less trouble, the War Department is tightening up on specifications. As the Washington representative of the box industry, I am very much inclined to agree with the War Department in most of its work, realizing that they are on the right track, and the box industry is thoroughly behind the War Department.

In conclusion, I believe that the problem of export boxing and packing, although being hurriedly worked out to meet war needs, will be solved so satisfactorily that we shall be ready for the largely increased export trade expected after the war.

Mr. Woolson. MR. I. H. WOOLSON.—I should like to ask Mr. Nellis if the Government is taking any cognizance of the pasteboard box as a shipping container. In the city I see boxes ranging from 2 to 4 ft. square of corrugated paper or other light materials that are in common use. These have come in since the war began and seem to be serving the purpose, goods being delivered even to dry goods stores in them. I do not know whether Committee D-10 has recognized any container of as low grade as that, but certainly it is in the market.

Mr. Nellis. MR. NELLIS.—As the Washington representative of the wooden box industry, I do not know that my answer to that question should be given as much weight as the answer of some other men. However, I was formerly connected with the Forest Service and am familiar with the whole proposition. The Food Administration the first of this year drew up specifications for canned-goods boxes, following the same specifications presented to the Society, and included, for domestic shipment,

nailed and lock-cornered wooden boxes, the wirebound veneer box, the corrugated fiber box, a solid fiber box, a wirebound fiber box, and for export use, nailed, strapped boxes and wirebound veneer boxes. That left the corrugated and solid fiber box for domestic use only. Answering your question directly, therefore, the Government has taken cognizance of the corrugated and solid fiber boxes, and such boxes are now in use. Mr. Nellis.

REPORT OF COMMITTEE D-11

ON

RUBBER PRODUCTS.

One general meeting of Committee D-11 has been held during the year in addition to meetings of sub-committees.

Sub-Committee I on Air Hose.—Proposed Tentative Specifications for Braided Leader Hose for Use with Pneumatic Tools have been presented by Sub-Committee I and adopted by the committee with the following vote: 19 affirmative, 3 negative, 4 not voting, 6 no reply. These specifications are appended herewith and it is recommended that they be accepted for publication as tentative.[1]

Sub-Committee II on Belting.—Sub-Committee II has prepared proposed Tentative Specifications for Rubber Belting for Power Transmission, which have been submitted to letter ballot of the committee with the following result: 19 affirmative, 3 negative, 4 not voting, 6 no reply. The specifications are appended to this report,[2] and it is recommended that they be accepted for publication as tentative.

Sub-Committee VI on Packing, Gaskets and Pump Valves.—Proposed Tentative Specifications for Rubber Pump Valves were presented to the committee for consideration, but they were returned to the sub-committee for revision.

In pursuance of a motion made at the meeting of the committee, seconded by the chairman of Sub-Committee VI, the sub-committee has been discharged and a new sub-committee will be appointed by the Advisory Committee, in order to expedite the work on packing, gaskets and pump valves.

Sub-Committee VII on Steam Hose.—Proposed Tentative Specifications for Steam Hose have been presented by this sub-committee and submitted to letter ballot of the committee, the following vote being returned: 20 affirmative, 2 negative, 4 not voting, 6 no reply. These specifications are also appended to this report,[3] with the recommendation that they be accepted for publication as tentative.

[1] See Addendum to report, p. 356.—Ed.
[2] See pp. 676–680.—Ed.
[3] See pp. 681–684.—Ed.

Sub-Committee IX on Rubber Insulating Tape.—Proposed Tentative Specifications for $\frac{3}{4}$-in. Rubber Friction Tape were presented by this sub-committee. They have been approved with reference to subject matter, but were returned to the sub-committee for modification as to form and are not yet ready for presentation to the Society.

The committee recommends that the following tentative specifications be advanced to standard:

Tentative Specifications for $2\frac{1}{2}$, 3 and $3\frac{1}{2}$-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use (D 26–16 T);[1]

Tentative Specifications for Insulated Wire and Cable; 30-per-cent Hevea Rubber (D 27–16 T);[2]

Tentative Specifications for Air-Line Hose for Pneumatic Tools (D 46–17 T).[3]

This report has been submitted to letter ballot of the committee, which consists of 31 members, of whom 22 have voted affirmatively, 3 negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

EDW. A. BARRIER,
Chairman.

F. M. WARING,
Secretary.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 732 (1917).
[2] *Ibid.*, p. 737. See Addendum to the report, p. 356.—ED.
[3] *Ibid.*, p. 763.

ADDENDUM

TO

REPORT OF COMMITTEE D-11.

In presenting the report of the committee, the secretary, Mr. S. C. Potts, stated that at a meeting of the committee held on Thursday evening, June 27, the committee voted to withdraw the proposed Tentative Specifications for Braided Leader Hose for Use with Pneumatic Tools for the further consideration of the committee; and that the committee had also voted to withdraw its recommendation that the Tentative Specifications for Insulated Wire and Cable: 30-per-cent Hevea Rubber be referred to letter ballot of the Society for adoption as standard and to recommend instead that these specifications be continued as tentative.

Editorial Note.

The recommendations of the committee contained in the Addendum to this report were approved at the annual meeting. The tentative specifications thus continued as tentative by this action appear on pages 650–675.

The two remaining tentative specifications referred to in the report were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on August 26, 1918, and appear in the 1918 Book of A.S.T.M. Standards.

The two remaining proposed tentative specifications referred to in the report were accepted for publication as tentative and appear on pages 676–684.

REPORT OF COMMITTEE D-13
ON
TEXTILE MATERIALS.

Since the last annual meeting of the Society, Committee D-13 has held two formal meetings; one at the Massachusetts Institute of Technology in Cambridge upon November 23, 1917, at which 18 members and 11 guests were present; the other in New York City at the United Engineering Societies Building upon May 4, 1918, at which 25 members and 19 guests were present.

At the meeting held at the Massachusetts Institute of Technology, Regulations Governing Committee D-13 were adopted, and are printed in Appendix I to this report.

A number of helpful investigations have been undertaken by members of the committee and the results of some of this work are appended to this report under the following titles:

Appendix II.—Table of Corrected Tensile Strengths of Fabric and Yarn at Various Moisture Regains, by W. O. Jelleme.

Appendix III.—Report of Sub-Committee IV on Testing Machines, by E. D. Walen, chairman.

Appendix IV.—Identification of Manila Fiber, by C. E. Swett.

Appendix V.—Effect of Moisture on the Strength of Aircraft Fabrics, by G. B. Haven.

List of Proposed Permanent Sub-Committees.

The list of sub-committees given below is not intended to be complete, but is offered as a suggestion for the division of the committee's work. Under the proposed plan of organization, new sub-committees may be created or new tasks assigned to old ones. It is assumed that the Advisory Board of Committee D-13 will from time to time suggest the creation of new

committees or, in case of conflict, determine the scope of sub-committees already in existence.

Sub-Committee I on Humidity.—To this sub-committee shall be assigned for investigation and report all questions arising out of the question of moisture in fabrics; as for instance, its control, measurement, and effect upon results of tests.

Sub-Committee II on Specimens.—To this sub-committee shall be assigned for investigation and report questions affecting the size, shape, selection, etc., of test specimens.

Sub-Committee III on Testing Machines.—This sub-committee shall investigate and report upon problems arising in connection with the machines used in making tests; as for instance, their design and inherent characteristics.

Sub-Committee IV on Classification and Identification of Fibers and Fabrics.—To this sub-committee shall be assigned the problem of properly grouping the various kinds of fabrics under various headings for the purpose of providing appropriate, general, or specified methods of testing.

Sub-Committee V on Nomenclature and Specifications.—The work of properly defining and standardizing the terms used in testing fabrics shall be assigned to this sub-committee.

Sub-Committee VI on Imperfections and Tolerances.—To this sub-committee shall be referred the problem of defining and classifying the various kinds of imperfections in textile materials.

Mr. A. E. Jury has been elected first vice-chairman and Mr. Kenneth Moller second vice-chairman of the committee.

At a subsequent meeting of the officers of the committee, the following sub-committees were appointed:

SUB-COMMITTEE I ON HUMIDITY.

Kenneth Moller, *Chairman,*
H. P. Babcock,
F. W. Daniel,
W. D. Hartshorne,
A. E. Jury,
H. V. R. Scheel,
E. D. Walen.

SUB-COMMITTEE II ON SPECIMENS.

A. E. Jury, *Chairman*,
J. W. Cooper,
E. E. Dearth,
R. M. Gage,
R. T. Griffith,
R. T. Rutledge,
F. W. Willard.

SUB-COMMITTEE III ON TESTING MACHINES.

E. D. Walen, *Chairman*,
E. V. Aldridge,
E. H. Barker,
H. V. R. Scheel,
H. L. Scott
G. W. Skirm,
L. T. Vance.

SUB-COMMITTEE IV ON CLASSIFICATION AND IDENTIFICATION OF FIBERS AND FABRICS.

C. E. Swett, *Chairman*,
D. A. Abrams,
R. P. M. Eagles,
T. A. Hicks,
C. M. Sears,
S. Turner.

SUB-COMMITTEE V ON NOMENCLATURE AND SPECIFICATIONS.

A. H. Clarke, *Chairman*,
C. S. Cook,
R. Dallis,
H. J. Jaquith,
W. B. Welsh.

SUB-COMMITTEE VI ON IMPERFECTIONS AND TOLERANCES.

E. H. Barnwell, *Chairman*,
R. A. Ballou,
C. B. Finckle,
E. H. Marble,
A. F. Warner,
L. A. Watts.

The Advisory Board of Committee D-13 as at present constituted is therefore as follows:

G. B. Haven, *Chairman*,
D. E. Douty, *Secretary*,
A. E. Jury, *First Vice-Chairman*,
K. Moller, *Second Vice-Chairman*,
E. H. Barnwell,
A. H. Clarke,
C. E. Swett,
E. D. Walen.

At the November meeting a long discussion took place of various aspects of textile testing and the outline of the work assigned to each sub-committee was thoroughly discussed.

During the months of December and January a questionnaire was conducted by the chairman of Committee D-13, among the various manufacturers and users of tire fabrics throughout the United States and Canada. Fifteen questions relating to testing practice were addressed to 88 concerns engaged in the above lines. Over 50 replied and gave very valuable information for the use of the various sub-committees, in studying fabric questions. The replies to this questionnaire were submitted in detail to all the members of Committee D-13.

At the New York meeting, sessions were held at 10 a. m. and 2 p. m. Mr. William D. Hartshorne, former chairman of the committee, read a most interesting paper upon the Effects of Moisture upon the Strength of Automobile Tire Fabric.

Reports were received from the chairmen of the six sub-committees, either in the form of recommended Tentative Standards or papers upon various subjects with which particular sub-committees had to deal. In this manner Mr. Kenneth Moller described a very novel conditioning room erected at the offices of The William Whitman Co. in Boston. Mr. E. D. Walen read a paper on "Testing Machine Errors," and Mr. A. H. Clarke described the scope of the work proposed for Sub-Committee V on Nomenclature and Specifications.

The committee discussed at great length the effect of moisture upon the tensile strength of fabrics. Mr. W. D. Hartshorne described a series of experiments, performed under his direction at the Massachusetts Institute of Technology, upon standard tire fabrics. His paper was illustrated by lantern slides and showed that the apparent tensile strength of tire fabric increases very rapidly with the absorption of moisture. His plotted results indicated that for certain ranges of moisture the apparent strength increases 7 per cent of the dry strength for each one per cent absorption. At the higher values of regain, however, the increase in apparent strength became less, possibly not over 5.5 or 6 per cent of the dry strength for each added per cent of regain.

The term "standard regain" has generally been applied to the percentage of moisture automatically absorbed by raw cotton when exposed for a more or less lengthy period in an atmosphere at a temperature of 70° F. and a humidity 65 per cent of saturation. This quantity has generally been stated as 8.5 per cent of the dry weight. All the members of the committee agreed that the above regain value was doubtless true for raw cotton exposed for long periods to high degrees of moisture, but expressed the belief that for manufactured cotton, where free access to the air was less perfect and where the regain was artificially produced by exposure of but a few hours in a "conditioning room" the value seldom exceeds 6.5 per cent of the dry weight. It was therefore proposed from practical considerations to define the "standard condition" of a fabric as that at which a moisture regain of 6.5 per cent of the dry weight has been attained.

The chairman exhibited a plot of the strength increase due to a moisture regain varying from 0 to 8.5 per cent, and it was noted that the results quite closely corroborated the results obtained by Mr. Hartshorne. This plot was the work of Messrs. Yeaton and Panettiere in the Textile Laboratory at the Massachusetts Institute of Technology and comprised accurate strength and regain determinations with the latter varying from zero to 9 per cent. The general character of the cloth curve is shown in Fig. 1.

The actual increase in tensile strength with moisture regain between bone dry and 8.5 per cent is indicated by the curved line *a b*. This is not a very abrupt curve, but approximates somewhat the straight dotted line *a b*. For the dotted line *a b* the rate of increase in tensile strength is 7 per cent for each added per cent of moisture for the fabric. This has lead some testing laboratories to adopt a method of correction for moisture regain. The samples are weighed in their natural condition and broken in rapid succession before the moisture present can change. The broken specimens are then weighed again after drying in an oven. This gives a means of computing the regain which was present at the time of testing. To reduce the tensile strength to a condition of complete moisture regain,

namely 8.5 per cent, it would be necessary first to divide the apparent strength by 100 + (7 × actual regain percentage at test), and then multiply by 100 + (7 × 8.5). This is equivalent to reducing the strength of the sample to a bone dry condition, on the assumption of 7 per cent strength increase for each per cent of regain, and then moving it up again on the same basis to a full regain of 8.5 per cent. Thus if a piece of tire fabric gave an apparent tensile strength of 260 lb. and was

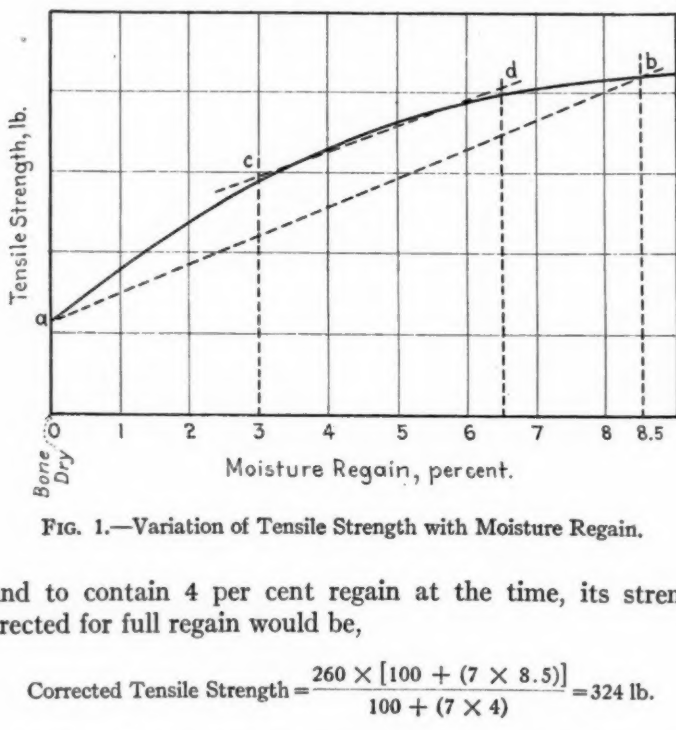

FIG. 1.—Variation of Tensile Strength with Moisture Regain.

found to contain 4 per cent regain at the time, its strength corrected for full regain would be,

$$\text{Corrected Tensile Strength} = \frac{260 \times [100 + (7 \times 8.5)]}{100 + (7 \times 4)} = 324 \text{ lb.}$$

If tire fabric could be made to move readily from the bone dry condition to full regain, the above method would suffice and give results very approximately correct. As a matter of practical fact, manufactured cotton in its natural state rarely contains less than 3 per cent nor more than 6.5 per cent regain. It was deemed wise by the committee, there-

fore, to set up these arbitrary limits in order to meet most nearly the actual working conditions. The full regain or "standard condition" has therefore been set at 6.5 per cent in the tentative standard appended to this report.

Between the above limits of 3 and 6.5 per cent regain the strength curve is more nearly approximated by the straight line *c d*, for which the rate of increase is very nearly 6 per cent of strength for each per cent of regain. For actual working conditions, therefore, the form of the correction equation should be, in the opinion of the committee,

$$\text{Corrected Tensile Strength} = \frac{\text{Apparent Strength} \times [100 + (6 \times 6.5)]}{100 + (6 \times \text{Actual Regain at Test})}$$

It is to be borne in mind that this formula is only applicable between regains of 3 and 6.5 per cent. It will not yield the bone dry strength on the assumption of zero regain, nor will it give full regain strengths on the basis of 8.5 per cent regain.

It is the belief of the committee that this method will obviate the haste and consequent inaccuracy of testing samples hot from the oven when the moisture regain and change in strength are most rapid. Obviously the necessary haste at this point often leads to poor placing in the jaws of the testing-machine, and widely varying results. Also if the above method is used as recommended it will largely eliminate the perplexity arising when the regain is either unknown or disregarded. It is the opinion of the committee that the above assumptions are sufficiently close for all classes of cotton fabrics and yarn where the fiber is employed in its natural state. Other fibers and those chemically treated will require strength-regain curves yet to be determined.

For assistance in reducing values of tensile strength, the Correction Table in Appendix II has been added.

As a result of this discussion, the committee recommends that the proposed Tentative General Methods for Testing Cotton Fabrics appended to this report[1] be published among the Tentative Standards of the Society, to supersede the present Tentative Methods of that title (D 39–16 T),[2] as well as the

[1] See pp. 709–715.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 829 (1917).

following three Tentative Tests, the essential requirements of which have been embodied in the proposed new methods:

Tentative Tests for Automobile Tire Fabrics (D 31–16 T);[1]

Tentative Tests for Cotton Fabrics for Use in Hose, Belting and Similar Articles (D 32–16 T);[2] and

Tentative Tests for Cotton Fabrics for Use in Bags and Bagging Material (D 33–16 T).[3]

This report has been submitted to letter ballot of the committee, which consists of 38 members, of whom 28 have voted affirmatively, 2 negatively and 8 have refrained from voting.

Respectfully submitted on behalf of the committee,

G. B. HAVEN,
Chairman.

D. E. DOUTY,
Secretary.

EDITORIAL NOTE.

The Tentative General Methods for Testing Cotton Fabrics, in the proposed revised form as referred to in this report, were continued as tentative and appear on pages 709–715.

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[1] *Ibid.*, p. 791.
[2] *Ibid.*, p. 793.
[3] *Ibid.*, p. 794.

APPENDIX I.

REGULATIONS GOVERNING COMMITTEE D-13
ON
TEXTILE MATERIALS.

Article I.

REGULATIONS.

Section 1. These Regulations are supplementary to the "Regulations Governing Standing Committees."

Article II.

MEMBERSHIP.

Section 1. The membership of Committee D-13 shall consist of those originally appointed and subsequently approved by the Executive Committee of the Society.

Sec. 2. Additional appointments to membership in this Committee shall be approved by not less than two-thirds of those voting by letter ballot, and subsequently approved by the Executive Committee of the Society.

Sec. 3. If a member or his authorized representative, without valid excuse, is absent from two consecutive regular meetings of the Committee, or fails to mark and return to the Secretary of the Committee two consecutive letter ballots, the Secretary shall, with the approval of the Advisory Board of this Committee, remove his name from the roll of membership.

Article III.

OFFICERS AND THEIR ELECTION.

Section 1. The officers of this Committee shall be a Chairman, a First Vice-Chairman, a Second Vice-Chairman, and a Secretary.

Sec. 2. The terms of office shall be for two years and officers shall be eligible for re-election.

SEC. 3. The election of officers shall be held at the regular meeting of this Committee during the annual meeting of the Society in the even-numbered years. Any vacancies may be filled for an unexpired term by election at any meeting.

ARTICLE IV.

DUTIES OF OFFICERS.

SECTION 1. The executive direction of the Committee shall be vested in an Advisory Board, which shall consist of the officers of the Committee and the chairmen of its various sub-committees, three members to constitute a quorum for the transaction of business.

SEC. 2. Sub-committees authorized by the Committee shall be appointed by the Advisory Board for two years, unless otherwise specified.

SEC. 3. The Chairman shall preside at all meetings of the Committee and be an *ex-officio* member of all sub-committees. He shall have custody of the rules, books, records, reports, and all other documents belonging to the Committee and copies of all the minutes of its sub-committees.

SEC. 4. The Secretary shall attend all the meetings of the Committee and keep the minutes thereof. He shall issue notices of all meetings and promptly inform sub-committees of their appointment and duties, at the request of the chairman. He shall keep a complete list of the members of the Committee with their addresses and a memorandum of the expenses of the Committee, and shall perform such other duties as may be delegated to him by the chairman.

ARTICLE V.

MEETINGS.

SECTION 1. Regular meetings of the Committee shall be held three times a year, in October, in March, and during the annual meeting of the Society prior to the presentation of the Annual Report of the Committee. The time and place of the meetings shall be fixed by the chairman.

SEC. 2. Special meetings may be called at the option of

the Chairman or at the written request of five members stating the reasons therefor.

SEC. 3. Notice of meetings shall be sent to members at least two weeks in advance of the meeting, stating the time and place at which the meeting will be held, and in the case of special meetings, the business to be transacted.

SEC. 4. Seven members, or their representatives authorized to vote for them, shall constitute a quorum for the transaction of business.

ARTICLE VI.

SUB-COMMITTEES.

SECTION 1. Sub-committees shall perform the duties assigned to them and shall present a written report, with definite recommendations, at each regular meeting of the Committee.

SEC. 2. The chairman of each sub-committee shall keep proper files of all correspondence and papers relating to the work of his sub-committee, which shall ultimately be transmitted to the Chairman of the Committee.

SEC. 3. No expense shall be incurred by any sub-committee except for postage, unless previously authorized by the Advisory Board.

ARTICLE VII.

AMENDMENTS.

SECTION 1. Amendments to these Regulations may be adopted by two-thirds vote of those voting by letter ballot.

APPENDIX II.

TABLE OF CORRECTED TENSILE STRENGTHS OF FABRIC AND YARN AT VARIOUS MOISTURE REGAINS.

Apparent Tensile Strength, lbs.	Moisture Regain in Fabric or Yarn.—Per cent of Dry Weight.														
	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
5	5.9	5.8	5.7	5.7	5.6	5.5	5.5	5.4	5.3	5.3	5.2	5.2	5.1	5.1	5
10	11.8	11.6	11.5	11.3	11.2	11.1	10.9	10.8	10.7	10.6	10.5	10.3	10.2	10.1	10
15	17.7	17.4	17.2	17.0	16.8	16.6	16.4	16.2	16.0	15.9	15.7	15.5	15.3	15.2	15
20	23.6	23.3	22.9	22.7	22.4	22.2	21.9	21.6	21.4	21.1	20.9	20.7	20.4	20.2	20
25	29.5	29.1	28.7	28.4	28.0	27.7	27.4	27.0	26.7	26.4	26.1	25.8	25.6	25.3	25
30	35.3	34.9	34.5	34.0	33.6	33.2	32.8	32.5	32.1	31.7	31.4	31.0	30.7	30.3	30
35	41.2	40.7	40.2	39.7	39.2	38.8	38.3	37.9	37.4	37.0	36.6	36.2	35.8	35.4	35
40	47.1	46.5	46.0	45.4	44.8	44.3	43.8	43.3	42.8	42.3	41.8	41.3	40.9	40.4	40
45	53.0	52.3	51.7	51.1	50.4	49.8	49.3	48.7	48.1	47.6	47.0	46.5	46.0	45.5	45
50	58.9	58.2	57.5	56.7	56.0	55.4	54.7	54.1	53.5	52.9	52.3	51.7	51.1	50.5	50
55	64.8	63.9	63.2	62.4	61.7	60.9	60.2	59.5	58.8	58.1	57.5	56.8	56.2	55.6	55
60	70.7	69.8	68.9	68.1	67.3	66.5	65.7	64.9	64.1	63.4	62.7	62.0	61.3	60.7	60
65	76.6	75.6	74.7	73.8	72.9	72.0	71.1	70.3	69.5	68.7	67.9	67.2	66.4	65.7	65
70	82.5	81.4	80.4	79.4	78.5	77.5	76.6	75.7	74.8	74.0	73.2	72.3	71.5	70.8	70
75	88.3	87.2	86.2	85.1	84.1	83.1	82.1	81.1	80.2	79.3	78.4	77.5	76.6	75.8	75
80	94.2	93.0	91.9	90.8	89.7	88.6	87.6	86.5	85.5	84.6	83.6	.82.7	81.8	80.9	80
85	100.1	98.9	97.7	96.4	95.3	94.1	93.0	91.9	90.9	89.8	88.8	87.8	86.9	85.9	85
90	106.0	104.7	103.4	102.1	100.9	99.7	98.5	97.4	96.2	95.1	94.1	93.0	92.0	91.0	90
95	111.9	110.5	109.1	107.8	106.5	105.4	104.0	102.8	101.6	100.4	99.3	98.2	97.1	96.0	95
100	117.8	116.3	114.9	113.5	112.1	110.8	109.4	108.2	106.9	105.7	104.5	103.3	102.2	101.1	100
105	123.7	122.1	120.6	119.1	117.7	116.3	114.9	113.6	112.3	111.0	109.7	108.5	107.3	106.1	105
110	129.6	127.9	126.4	124.8	123.3	121.8	120.4	119.0	117.6	116.3	115.0	113.7	112.4	111.2	110
115	135.5	133.7	132.1	130.5	128.9	127.4	125.9	124.4	123.0	121.6	120.2	118.8	117.5	116.3	115
120	141.4	139.6	137.9	136.2	134.5	132.9	131.0	129.8	128.3	126.8	125.4	124.0	122.6	121.3	120
125	147.3	145.4	143.6	141.8	140.1	138.4	136.8	135.2	133.7	132.1	130.6	129.2	127.8	126.4	125
130	153.1	151.2	149.3	147.5	145.7	144.0	142.3	140.6	139.0	137.4	135.9	134.3	132.9	131.4	130
135	159.0	157.0	155.1	153.2	151.3	149.5	147.8	146.0	144.3	142.7	141.1	139.5	138.0	136 5	135
140	164.9	162.8	160.8	158.9	156.9	155.1	153.2	151.4	149.7	148.0	146.3	144.7	143.1	141.5	140
145	170.8	168.6	166.6	165.4	162.5	160.6	158.7	156.8	155.0	153.3	151.5	149.9	148.2	146.6	145
150	176.7	174.4	172 3	170.2	168.1	166.1	164.2	162.3	160.4	158.6	156.8	155.0	153.3	151.6	150
155	182.6	180.3	178.1	175.9	173.7	171.7	169.6	167.7	165.7	163.8	162.0	160.2	158.4	156.7	155
160	188.5	186.1	183.8	181.6	179.4	177.2	175.1	173.0	171.1	169.1	167.2	165.4	163.5	161.7	160
165	194.4	191.9	189.5	187.2	185.0	182.7	180.6	178.5	176.4	174.4	172.4	170.5	168.6	166.8	165
170	200.3	197.7	195.3	192.9	190.6	188.3	186.1	183.9	181.8	179.7	177.7	175.7	173.7	171.9	170
175	206.1	203.5	201.0	198.6	196.2	193.8	191.5	189.3	187.1	185.0	182.9	180.9	178.9	176.9	175
180	212.0	209.3	206.8	204.2	201.8	199.4	197.0	194.7	192.5	190.3	188.1	186.0	184.0	182.0	180
185	217.9	215.1	212.5	209.9	207.4	204.9	292.5	200.1	197.8	195.6	193.3	191.2	189.1	187.0	185
190	223.8	220.9	218.3	215.6	213.0	210.4	208.0	205.5	203.2	200.8	198.6	196.4	194.2	192.1	190
195	229.7	226.8	224.0	221.3	218.6	216.0	213.4	210.9	208.5	206.1	203.8	201.5	199.3	197.1	195
200	235.6	232.6	229.8	226.9	224.2	221.5	218.9	216.3	213.8	211.4	209.0	206.7	204.4	202.1	200
205	241.5	238.4	235.5	232.6	229.8	227.1	224.4	221.8	219.2	216.7	214.2	211.9	209.5	207.2	205
210	247.4	244.2	241.2	238.3	235.4	232.6	229.8	227.2	224.5	222.0	219.5	217.0	214.6	212.3	210
215	253.3	250.0	247.0	244.0	240.0	238.1	235.3	232.6	229.9	227.3	224.7	222.2	219.7	217.3	215
220	259.2	255.9	252.7	249.6	246.6	243.7	240.8	238.0	235.2	232.5	229.9	227.4	224.9	222.4	220
225	265.1	261.7	258.5	255.3	252.2	249.2	246.3	243.4	240.6	237.8	235.2	232.5	230.0	227.5	225

TABLE OF CORRECTED TENSILE STRENGTHS OF FABRIC, ETC. (*Continued*).

Apparent Tensile Strength, lbs.	Moisture Regain in Fabric or Yarn.—Per cent of Dry Weight.														
	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
230	270.9	267.5	264.2	261.0	257.8	254.7	251.7	248.8	245.9	243.1	240.4	237.7	235.1	232.5	230
235	276.8	273.3	270.0	266.7	263.4	260.3	257.2	254.2	251.3	248.4	245.6	242.9	240.2	237.6	235
240	282.7	279.1	275.7	272.3	269.0	265.8	262.7	259.6	256.6	253.7	250.8	248.0	245.3	242.6	240
245	288.6	285.0	281.4	278.0	274.6	271.4	268.1	265.0	262.0	259.0	256.1	253.2	250.4	247.7	245
250	294.5	290.7	287.2	283.7	280.1	276.9	273.6	270.4	267.3	264.3	261.3	258.4	255.5	252.7	250
255	300.4	296.6	292.9	289.3	285.8	282.4	279.1	275.8	272.7	269.5	266.5	263.5	260.6	257.8	255
260	306.3	302.4	298.7	295.0	291.5	288.0	284.6	281.2	278.0	274.8	271.7	268.7	265.7	262.8	260
265	312.1	308.2	304.4	300.7	297.1	293.5	290.0	286.7	283.4	280.1	277.0	273.9	270.8	267.9	265
270	318.1	314.0	310.2	306.4	302.6	299.0	295.5	292.1	288.7	285.4	282.2	279.0	276.0	272.9	270
275	323.9	319.8	315.9	312.0	308.3	304.6	301.0	297.5	294.0	290.7	287.4	284.2	281.1	278.0	275
280	329.8	325.6	321.7	317.7	313.9	301.1	306.5	302.9	299.4	296.0	292.6	289.4	286.2	283.1	280
285	335.7	331.5	327.4	323.4	319.5	315.7	311.9	308.3	304.7	301.3	297.9	294.5	291.3	288.1	285
290	341.6	337.3	333.1	329.1	325.1	321.2	317.4	313.7	310.1	306.5	303.1	299.7	296.4	293.2	290
295	347.5	343.1	338.9	334.7	330.7	326.7	322.9	319.1	315.4	311.8	308.3	304.9	301.5	298.2	295
300	353.4	348.9	344.6	340.4	336.3	332.3	328.3	324.5	320.7	317.1	313.5	310.0	306.6	303.3	300
305	359.3	354.7	350.4	346.1	341.9	337.8	333.8	329.9	326.1	322.4	318.8	315.2	311.7	308.3	305
310	365.2	360.5	356.1	351.8	347.5	343.3	339.3	335.3	331.5	327.7	324.0	320.4	316.8	313.4	310
315	371.1	366.4	361.9	357.4	353.1	348.9	344.8	340.7	336.8	333.0	329.2	325.5	321.9	318.4	315
320	376.9	372.2	367.6	363.1	358.7	354.4	350.2	346.1	342.2	338.3	334.4	330.7	327.1	323.5	320
325	382.8	378.0	373.3	368.8	364.3	360.0	355.7	351.6	347.5	343.5	339.7	335.9	332.2	328.5	325
330	388.7	383.8	379.1	374.4	369.9	365.5	361.2	357.0	352.8	348.8	344.9	341.0	337.3	333.6	330
335	394.6	389.6	384.8	380.1	375.5	371.0	366.7	362.4	358.2	354.1	350.1	346.2	342.4	338.8	335
340	400.5	395.4	390.6	385.8	381.1	376.6	372.1	367.8	363.5	359.4	355.3	351.4	347.5	343.7	340
345	406.4	401.3	396.3	391.5	386.7	382.1	377.6	373.2	368.9	364.8	360.6	356.5	352.6	348.8	345
350	412.3	407.1	402.1	397.1	392.3	387.6	383.1	378.6	374.2	370.0	365.8	361.7	357.7	353.8	350
355	418.2	412.9	407.8	402.8	397.9	393.2	388.5	384.0	379.6	375.2	371.0	366.9	362.8	358.9	355
360	424.1	418.7	413.6	408.5	403.5	398.7	394.0	389.4	384.9	380.5	376.2	372.0	367.9	363.9	360
365	429.9	424.5	419.3	414.2	409.2	404.3	399.5	394.8	390.3	385.8	381.5	377.2	373.1	369.0	365
370	435.8	430.3	425.0	419.8	414.8	409.8	405.0	400.2	395.6	391.1	386.7	382.4	378.2	374.0	370
375	441.7	436.2	430.8	425.5	420.4	415.3	410.4	405.6	401.0	396.4	391.9	387.5	383.3	379.1	375
380	447.6	442.0	436.5	431.2	426.0	420.9	415.9	411.1	406.3	401.7	397.1	392.7	388.4	384.1	380
385	453.5	447.8	442.3	436.9	431.6	426.4	421.4	416.5	411.7	407.0	402.4	397.9	393.5	389.2	385
390	459.4	453.6	448.0	442.5	437.2	432.0	426.9	421.9	417.0	412.2	407.6	403.0	398.6	394.3	390
395	465.3	459.4	453.8	448.2	442.8	437.5	432.3	427.3	422.3	417.5	412.8	408.2	403.7	399.3	395
400	471.2	465.2	459.5	453.9	448.4	443.0	437.8	432.7	427.7	422.8	418.0	413.4	408.7	404.4	400

EXPLANATION.—A sample of fabric in its natural state gave an apparent tensile strength of 210 lb. After drying its moisture regain at the time of the test was found to have been 4.75 per cent of the dry weight. In the line opposite 210 and under 4.75 regain in the table will be found the figure 227.2, the strength of the fabric corrected to a full regain of 6.5 per cent. In the same manner a fabric with an apparent strength of 192 lb. and a regain of 5.25 per cent would have a corrected strength of 202.9 as determined by interpolation from the table.

APPENDIX III.

REPORT OF SUB-COMMITTEE III
ON
TESTING MACHINES.

A survey of the types of testing machines used in the several countries testing textile materials divides them into two distinct classes:

1. Constant increment of load;
2. Constant increment of stretch.

The constant-increment-of-load machines apply the load by uniformly increasing the tension in very small increments. There are a few isolated cases in which the load is increased by appreciable amounts at stated intervals of time.

The constant-increment-of-stretch machines apply the load by stretching the material at a uniform rate, and because of their simplicity and rapidity of operation have found much favor with textile men both in this country and abroad.

The progress of testing machine development in England, particularly during the war, is rather interesting. For a long time the two types of machines were in general use, but the constant-increment-of-stretch machine was the one most used. At the beginning of the war the problem of studying air-craft fabrics was given to the National Physical Laboratory, which has much the same relation to English industry as the Bureau of Standards has to American industry. In the study of such fabrics, it is extremely desirable to use a machine such that the results of tests obtained from its use may not involve machine characteristics. They developed what is now the Avery testing machine, and the English Government insists that all aeronautical fabrics be tested on that particular machine.

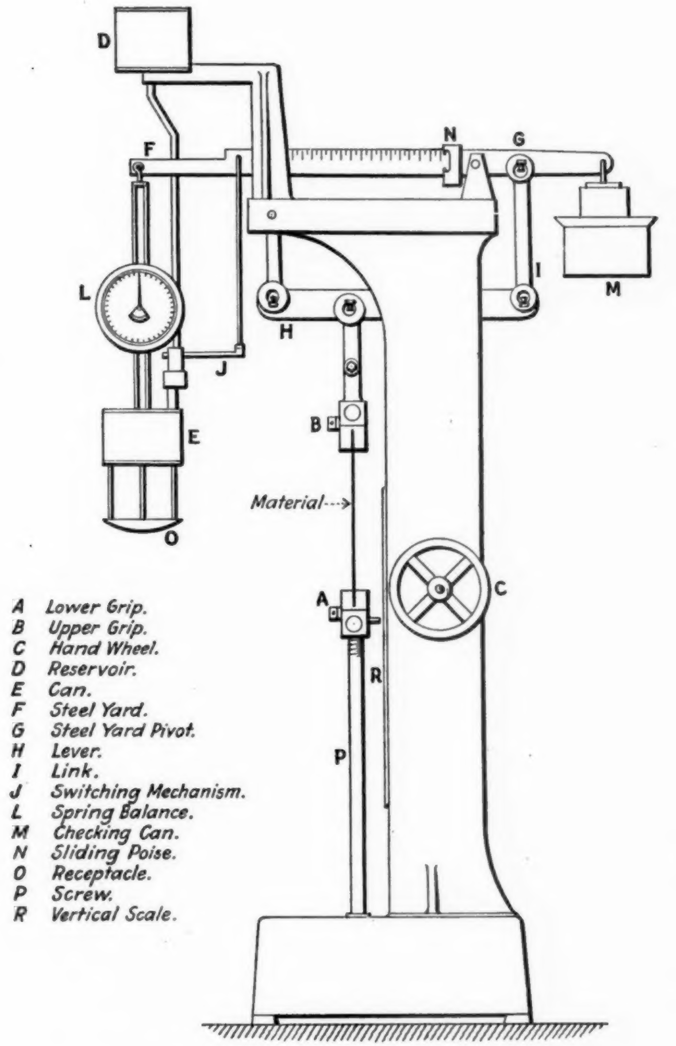

FIG. 1.—Avery Fabric Testing Machine.

The Avery machine is illustrated in Fig. 1. Its principle is not new, but the mechanical design is quite an improvement upon the Goodhand and Smith machines of this type. It consists briefly of a compound lever, having at one end of the system a shot container so arranged to allow of a uniform rate of inflow and at the other end a fabric clamp. The shot container is allowed to be uniformly increased in weight and the balance beam kept at zero by taking up the stretch of the sample. Provision is made to cut off the supply of shot at the time of breaking of sample. A spring balance interposed between the shot container and balance arm allows the increase of weight of the container to be quickly observed.

It has been observed that within certain limits a change in the rate of loading produces practically no change in the physical properties of the material. The Avery machine is operated, in accordance with specifications, within these limits and as a result the rate of loading varies with the kind of material being tested.

The development and use of this machine show a very careful study and consideration of the tensile properties of the material to be tested. The machine is theoretically very good, but the personal equation and time of operation is so large that its practical utility is questioned.

If the constant-increment-of-stretch machine had no machine characteristics, the results of tests on this type of machine would correspond with those obtained from a constant-increment-of-load machine, provided both were operated between the limits which define the relations of stretch, load and time, within which a change in the rate of load application produces only a slight change in properties.

The constant-increment-of-stretch machines may be classified according to the method of recording the load transmitted by the fabric:

1. Inclination balance;
2. Elastic system (such as a spring).

The rigidity of construction, ease of operation and so-called "dead weight" feature of the inclination balance type of head—together with the fact that springs were not, in the past, constructed to give constancy of operation—has caused the first

type to be used almost universally in this country and in Germany. This type is illustrated in Fig. 2.

The theory and calibration of an inclination balance machine assumes a null method of weighing, that is, the balance

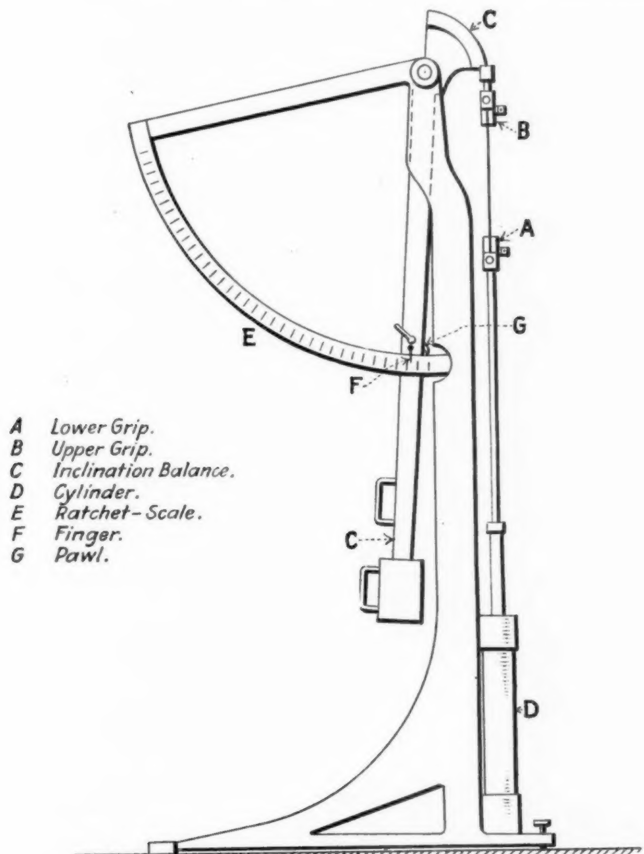

FIG. 2.—Schopper Fabric Testing Machine: Inclination Balance Type.

or poise arm is at rest. This condition is entirely changed during the test by the inertia of the moving balance arm. The calibration is therefore not applicable to the machine as used. The error may be expressed as a function of the mass of the

moving body multiplied by the acceleration. Obviously the acceleration changes with each different kind of material, shape and size of specimen, and speed of operation, and the total inertia component changes with the design and capacity of the machine. This is particularly emphasized in testing the same fabric on machines of different capacities; it is an established fact that results are different. From this it is readily seen that the results of tests of different fabrics on machines of the same capacity are influenced materially by the machine characteristics. All tests made on such machines include machine characteristics which vary with the variables of the test specimen, including nature of material, dimensions of test specimen, and rate of testing.

The use of this machine to check up deliveries is quite reasonable, for it is assumed that the machine characteristics are included in the specifications automatically and are constant for any one fabric and any one size and type of testing machine. Specifications based on tests made on this type of machine should specify the size, type and make of machine and rate of operation, as well as the specimen dimensions.

For investigational work, however, such as the comparison of the properties of different fabrics and the determination of the effect of varying the size of sample, it is clear that the results are very misleading if they include machine characteristics. The errors introduced become infinitesimally small as the speed of the moving arm approaches zero as a limit.

The use of an elastic system for recording the load transmitted eliminates the variables introduced by the inclination balance, provided the mechanical design is good, and it has the advantage of rapid and positive operation. Unfortunately, very little attention has been paid to the design of such machines and the variance introduced has caused them to be much in disfavor.

As the situation presents itself, there are two courses open for improvement and standardization of machines for testing textile materials:

First, the standardization of existing machines, which practically means only one make, one capacity and the same dimensions of the same moving parts; otherwise there will

still exist confusion of results caused by the testing of materials on machines having different machine characteristics.

Second, the re-design of the principle of the recording

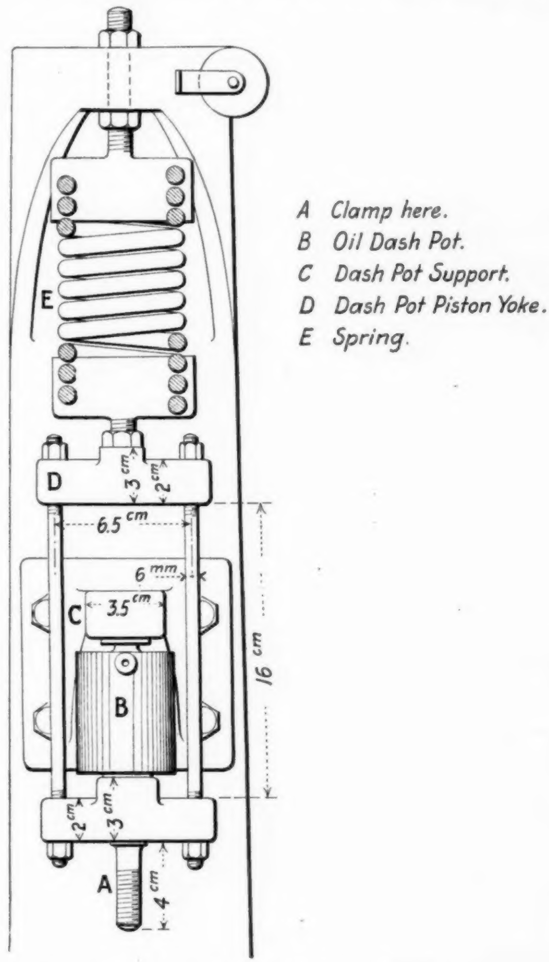

FIG. 3.—Head of Bureau of Standards Fabric Testing Machine.

head of the testing machine, such that the results obtained are independent of the machine.

The second consideration is practically as easy to effect

as the first, and has the advantage of being based on sound mechanics.

It may be asked why the Bureau of Standards has recommended that a particular make and size of inclination balance testing machine be used by the military departments during the present crisis. The military departments, such as the Quartermaster's Department and Signal Corps, were confronted with the problem of checking large deliveries immediately. Under these conditions the Bureau of Standards recommended one size of test specimen, one speed of operation, one make and one capacity of inclination balance testing machine, regardless of whether any one condition of the test was fundamentally sound. The main object was to obtain uniform test methods at once.

For investigational work such as Committee D-13 contemplates, however, the testing machines used should be fundamentally correct.

The requirements of a testing machine are:

1. Rigidity;
2. As nearly automatic operation as is possible;
3. Recording head free from objectionable characteristics caused by (*a*) Principle, (*b*) Mechanical design.

The Bureau of Standards has been experimenting with a testing machine which as a whole has no value as a commercial machine, but which has shown itself to be reasonably constant and free from machine characteristics. It is constructed on the constant-increment-of-stretch principle and has a recording head of a suspended spiral spring and oil dash pot to take care of recoil. The head is illustrated in Fig. 3.

From the results obtained with this machine the Bureau is re-designing the present testing machines along these lines, with the addition of a temperature correcting device and an individual test result totalizer. The construction is rigid and simple, and the operation a little quicker and as automatic as that of any existing machines.

Respectfully submitted,

E. D. WALEN,
Chairman.

APPENDIX IV.

IDENTIFICATION OF MANILA FIBER.

By C. E. Swett.

The substance of the following paper was presented to Committee D-13 at its meeting held November 23, 1917, at Cambridge, Mass., and was subsequently published in the *Journal of Industrial and Engineering Chemistry*.

In the rope industry fibers are classed as "soft," hemp, jute, linen, cotton, etc., and "hard," as manila (musa), sisal (agave), maguey, New Zealand (*Phormium tenax*) and others. In general, the hard fibers are lignified. Among the soft fibers jute also is a lignified fiber, but its physical characteristics place it beside hemp.

The two hard fibers of preëminent importance are manila and sisal.

The distinction between manila and sisal is not easily made, except by a practical ropemaker and not always by him, especially when they occur together in rope.

When it is desired to estimate the amounts of the two present in a given rope the microscope has to be used. The cross-sections are characteristic but not in all cases satisfactory. For instance, sisal from East Africa is sufficiently different from manila to enable one to separate them, but sisal from Yucatan (henequin) is not always enough different to make it possible to say how much may be present.

The sections are not easy to make and when made may contain thousands of fibers. When it is considered that the field under magnification to 200 diameters is of the order of one millimeter and that a rope of 2 or 3 in. of cross-section may have to be examined, it will be understood that some method for differentiating these fibers other than the employment of the microscope would be of great use.

Such a method has been worked out in the laboratory of Arthur D. Little, Inc., and is here described in some detail.

If the sample is treated with a solution of bleaching powder acidulated with acetic acid, then with ammonia, manila takes a russet-brown color. All other hard fibers turn cherry-red. Thus it becomes possible to distinguish manila from all the others, which is the matter of chief importance.

SOLUTIONS REQUIRED.

1. *Ether*, to pour down a strand to remove most of the spinning oil.

2. *Bleaching Powder Solution.*—A clear solution of chloride of lime, containing about 5 per cent of available chlorine, acidulated with acetic acid (30 cc. of bleaching solution and 2 cc. glacial acetic acid).

Acidulation with an acid stronger than acetic will not answer; for example, hydrochloric acid will give no test.

3. *Water* to rinse after the above.

4. *Alcohol* to remove water.

5. *Strong Ammonia*.

PRELIMINARY EXAMINATION OF THE SAMPLE.

Remove most of the oil by pouring ether down the strand. Wave through the air for a minute or two to remove most of the ether; immerse one end of the sample in the acidulated bleach solution for 20 seconds; rinse first with water, then with alcohol and then immerse in ammonia.

Manila will instantly turn brown.

Sisal, New Zealand, istle, Mauritius, maguey will assume a cherry-red.

When so applied the test is somewhat fugitive, the red color degrading in the course of a few minutes so that it may not be possible to pick out the different colored fibers from the strand. As applied it enables one to say whether the sample is all manila, all non-manila or a mixture. This is all that is required in many instances.

When it becomes necessary to estimate the percentages of manila and non-manila the procedure is as follows:

Apply the test as before but instead of immersing the fibers in ammonia in the last operation, suspend the treated

end of the strand above the ammonia for a minute or so. As thus practiced the manila does not assume the brown color as rapidly, but at the end of 2 or 3 minutes the color develops and is permanent.

The cherry-red of the non-manila fibers remains for hours and a separation may be made by picking out the red or the brown. A reading glass is of assistance.

When the separation is made as above it is desirable to take the two differently colored strands and apply the test as first described, that is, by treating the hitherto untreated ends with ether, immersing in bleach acetic solution, rinsing with water and then immersing in ammonia. This serves as a check and as the separation will be closely approximate as a result of the fuming test, the few fibers which may show up as wrongly placed can be removed with ease.

One desiring to practice this test should first work on samples of known origin. With practice it seems to be possible to estimate the manila content of a rope down to a single fiber. As the test is so quickly applied it is the writer's practice to take less than a strand for treatment and then go through the sample taking, perhaps, 20 or 30 fibers at a time.

The difference between the red and the brown is most evident at the end of 3 or 4 minutes after fuming with the ammonia.

The bleach solution made with one part of chloride of lime and seven parts of water, then filtered, may be kept in a stoppered amber bottle away from the light for a long time. When some is to be used it should be poured from the stock solution and acidulated with the acetic acid for present use. Throw away when the tests are done; it will not keep in an acidulated condition.

Chlorine water will not serve, neither will iodine solution or bromine water; nor will any acid tried answer so well as acetic.

Too much emphasis cannot be placed on the fact that hydrochloric or other strong acid is not suitable to replace acetic acid as used in this test. This reiteration is made because, notwithstanding specific instructions, two competent chemists have assumed that because the test failed with hydrochloric acid there was nothing in it. In neither case were the directions followed and when attention was called to this fact no trouble was experienced in securing the appearances described.

APPENDIX V.

EFFECT OF MOISTURE ON THE TENSILE STRENGTH OF AIRCRAFT FABRICS.

By G. B. Haven.

The growing importance of the airplane, not alone in military operations, but in civil life as well, has brought into sudden prominence many constructive materials hitherto largely unrecognized. Chief among these are the various forms of textile fabrics used as the basis of strength in wings, bodies, rudders and tires for the airplane, and for the gas bags of balloons and dirigibles. The primitive experiments in this line, where silk and other rare and costly fibers were used, have largely passed, and the question has become that of the relative excellence of linen and cotton for the above purposes. Unfortunately, the basis of supply of linen is to a great extent enveloped in the territory of the present conflict, and cannot therefore be depended upon to produce the necessary amount of this desirable fiber. Hence, the material preëminent for the above purposes appears to be cotton. Much thorough endeavor and study has of late been put forth in the direction of producing more reliable and uniform cotton fabrics of the above character.

Effect of Moisture.

It is a well-known fact that cotton and linen are hygroscopic to a marked degree, gathering to themselves automatically a large percentage of their dry weight in the form of moisture. The effect of this "regain" upon the tensile strength is very pronounced. In thick, heavy fabrics such as those used for tires, the strength may be augmented to the extent of 50 per cent or more by the presence of this moisture of regain. In light wing fabric the increase is of less amount, but there is, however, a decided effect in all of these fabrics from this cause.

Naturally, in order to apply and enforce specifications for mechanical fabrics, it is necessary to test them with precision and to achieve results which can be interpreted intelligently and accurately. If fabrics are tested promiscuously with regard to moisture condition the results will vary so widely that but little real knowledge of the character of the fabric will be gained.

METHODS OF TESTING.

Three methods have been proposed for use in testing textiles:

(*a*) Bone dry;

(*b*) Under standard atmospheric conditions at full regain;

(*c*) Under any prevailing atmospheric condition with the result corrected for the actual moisture present at the time of the test.

Oven Tests.—Bone-dry tests are usually made by drying the samples in an electric oven until the further loss of weight is so minute as to be negligible. In most modern ovens the temperature is under the control of a thermostat set slightly above the boiling point of water, namely, from 220 to 230° F. Upon the roof of the oven is mounted a set of fine balances which weigh the textile specimens in the oven by means of a basket and link connected directly to the scale pan. This method obviates the necessity of opening the oven door or of removing the samples from the heat. The specimens after becoming thoroughly dry, are removed quickly in succession from the oven, inserted in a testing machine and broken, the time consumed after removal from the heat being about 30 seconds. With expert operation this interval can be reduced to about 18 seconds.

There are three difficulties with testing specimens bone dry. First, the ascending currents of heated air in the oven interfere with accurate weights of much less than 0.1 grain. Second, the necessary haste in transferring the dry specimen to the machine generally results in a haphazard and inaccurate insertion of the specimen between the jaws, with the result that very few of the samples break in the center, but rather tear at the jaw at a reduced strength. Third, the necessary interval of time permits the reabsorption of a moderate amount

of moisture before the specimen can be broken and therefore increases the apparent tensile strength to a considerable degree. It is evident that this method is neither satisfactory nor accurate for the above three reasons. The weighings should be carried to a precision of 0.01 grain in order to secure the second significant figure in the moisture percentage. The sample should be inserted in the machine with great accuracy and care in order that the full strength may be indicated and the failure may occur in the center of the test piece. And, lastly, if tests are to be rated as bone dry they should take place before any perceptible regain of moisture has occurred.

"Standard Atmosphere" Tests.—The second method of testing textiles under standard atmospheric conditions has many things to commend it. The fabric here has full opportunity to reach a condition of moisture equilibrium provided the exposure in the atmosphere is four hours or more. There need be no special haste in operating the testing machine, consequently accurate results may be obtained. The atmospheric conditions which have been widely adopted are 70° F. and 65 per cent relative humidity. It is of course easy to maintain a room temperature of 70° F. for a large portion of the year by means of a thermostat. Many forms of apparatus have been devised and are upon the market to raise the humidity from low figures to a limit of 65 per cent and hold it there automatically with but little variation. Such apparatus is relatively inexpensive and frequently forms a part of the equipment of modern cotton mills. During a large portion of the year, however, the natural outdoor humidity exceeds 65 per cent, and in order to take the excess moisture from the air, expensive and complicated refrigerating apparatus is necessary. There are but few laboratories in the country where this can be done under all sorts of external conditions with accuracy. Therefore, it is exceedingly doubtful whether this method will ever be broadly adopted by textile mills for use in their testing rooms. It is a mistake simply to provide a testing room with a great abundance of artificial moisture, as is often done in cotton mills. The results from tests conducted under such conditions will be but little more uniform than tests conducted haphazard.

"Correction for Moisture" Tests.—For practical use the third method of testing, namely, by correcting the apparent

strength for the actual moisture present at the time, appears to many to be the final solution of this perplexing question. It will enable the mill owner to test his products without the use of complicated or expensive apparatus, and with but little expert assistance. Tests can be made at any time with but little delay. The reliability of this method, however, depends wholly upon an accurate plot of the effect of moisture upon the tensile strength of the actual fabric in question. The plotting of such strength-regain curves is a matter for the physical laboratory alone, and must be conducted with great precision if the results are to be trusted. When once such a plot is obtained, the actual amount of moisture in the fabric under any atmospheric condition forms an accurate basis for the correction of the apparent tensile strength to that at a standard condition of moisture regain. To bring the results of such tests to a common point of understanding, it has been suggested in the deliberations of Committee D-13 on Textile Materials that all apparent strengths be corrected for moisture to a common basis of 6.5 per cent regain. While this method has not been widely adopted as yet, it is believed that it will essentially simplify the testing of textiles and remove much of the misunderstanding and contradiction which has been evident heretofore.

OBJECT OF RESEARCH.

It is the object of this paper to describe a series of experiments conducted by the author with the able assistance of Mr. Philip O. Yeaton of the Mechanical Engineering staff at the Institute of Technology. All of the work here described was performed in the Textile Testing Laboratory within the last year and forms part of the course of instruction given to Detachments of the Navy studying airplanes at the Institute.

FABRICS TESTED

Five fabrics may be classed under the general title, "Aircraft Fabrics:"

1. Cotton fabric for wings;
2. Linen fabric for wings;
3. Rubberized fabrics for kites, balloons and dirigibles;
4. Woven tire fabric;
5. Cord tire fabric.

DESCRIPTION OF FABRICS.

(*a*) *Wing Cotton.*—Two classes of cotton wing fabric are advocated by the United States Government bureaus, one woven of two-ply No. 60 yarn and the other of three-ply No. 80 yarn. The weight of these fabrics is from 4 to 4.5 oz. per sq. yd. The yarn is generally mercerized under tension and from 70 to 80 threads per inch of width are employed in both warp and filling. The following tests were made upon the three-ply No. 80 mercerized fabric having a weight of approximately 4 oz. per sq. yd.

(*b*) *Wing Linen.*—The wing linen imported into this country from Ireland, France and Belgium has generally about 94 threads per inch in warp and filling and weighs about $3\frac{3}{4}$ oz. per sq. yd. It passes from a creamy white color to a dull brown and may be found in grades much heavier than the above.

(*c*) *Balloon Fabric.*—Balloon fabric is made by calendering and vulcanizing thin sheets of para rubber upon fine cotton cloth. One, two or three plies of cloth may be employed. With two or three plies, the direction of the threads in the fabrics is made to form an angle of 45 deg. with one another in order to localize tears. The cloth count varies from 120 to 160 threads per inch of width in warp and filling. That used in the following tests had quite uniformly 133 threads per inch in warp and filling. The fabric was two-ply with a nominal weight of 11 oz. per sq. yd. Other fabrics of this class range from 4 to 15 oz. per sq. yd. The ply which has its warp threads in the direction of the length of the fabric as rolled is called the "parallel-ply" and the one with its threads at 45 deg. with the roll length, the "bias-ply."

(*d*) *Tire Fabric.*—Woven tire fabric has been widely standardized with 23 threads per inch of width in warp and filling. The threads are made of No. 23 yarn plied eleven times. The weight is generally $17\frac{1}{4}$ oz. per sq. yd.

(*e*) *Cords.*—Cord tire fabric, or "cords" as it is frequently called, has 23 warp threads per inch of width. These cords are cabled, that is, made up of three strands, and each strand of five primary No. 23 yarns. Thus the warp threads are virtually 15-ply yarns. In order to assemble the warp threads or cords in order, filling threads of single No. 23 yarn are inserted to the

number of $2\frac{1}{2}$ per inch. The warp threads are thus loosely held in order until placed in the tire. The weight of this fabric is about 15 oz. per sq. yd.

The highest grades of cotton are used in all these fabrics. Sea Island, imported and domestic Egyptian and the better classes of Peeler are generally specified. The cotton is generally combed in process of manufacture.

APPARATUS.

The facilities of the Institute of Technology for research in this direction are as follows:

(*a*) A testing room of about 5000 cu. ft. capacity, with heavy concrete walls and floors and tight doors and windows.

(*b*) A Park's humidifying system in the testing room with automatic control. This apparatus will raise the humidity to a set figure and hold it there with but little variation.

(*c*) An Emerson electric conditioning oven with thermostat control. The latter is adjustable to any reasonable figure and has a limit of variation of 2° F. plus and minus. The oven contains eight aluminum weighing baskets carried on turntables. On the oven roof is mounted a pair of fine balances weighing to 0.1 grain. Any basket may be linked to the scale pan and weighed without opening the oven door. The links and baskets are tared by dead weights on the scales so that the net weight of the sample is obtained without subtraction. The oven is thoroughly ventilated while in operation.

(*d*) Three Scott testing machines were employed, having capacities ranging from 50 to 800 lb. The clamp jaws were of the flat hinged type wider in all cases than the strip of fabric under test. The distance from the machines to the oven door was 3, 6 and 8 ft. respectively. The speed of the testing machine jaws was 12 in. per minute in all cases.

(*e*) *Balances.*—All the weighings for the plots were made on Becker Analytical balances to 0.01 grain. Great care was expended in securing the last significant figure in the weighings.

(*f*) *Weighing Bottles.*—In order to hold specimens at stable humidity while weighing, bottles of thin glass with airtight ground-glass stoppers were employed. Their capacity

was 40 cc. and they easily accommodated four or five of the strips to be tested.

(*g*) *Wet Room.*—Where extremely high humidity regains were desired, recourse was had to a room without windows in the basement of the institute. This room is kept continually as near 100 per cent relative humidity as possible by an American humidifier. In the exposures made in these tests the apparatus was shut down to avoid spray until the relative humidity was not over 95 per cent. The specimens were hung 6 ft. away from and 2 ft. above the level of the humidifier.

In addition to the above, the usual complement of cutting, counting and measuring apparatus was available. All the specimens were accurately measured off in width by means of a Lowinson thread micrometer over an illuminated field of ground glass.

TABLE I.—DIMENSIONS OF SPECIMENS.

Kind of Fabric.	Specimen.		Raveled to	Distance between Jaws, in.
	Length, in.	Width, in.		
Wing Cotton	7	$1\frac{1}{4}$	1 in.	3
Wing Linen	7	$1\frac{1}{4}$	1 in.	3
Balloon	6	$1\frac{1}{2}$	Not raveled	3
Woven Tire	7	$1\frac{1}{2}$	23 threads.	3
Cords	16	One cord	....	10

SPECIMENS.

All the specimens were cut to the definite length and width given in Table I.

PRELIMINARY TESTS

Before proceeding to the actual questions at issue, certain preliminary facts were established by a series of tests.

(*a*) Does the duration of heat in the oven, temperature 220–230° F., influence the tensile strength of the fabrics in question? To answer this, 65 tire-fabric and 32 balloon-fabric samples were heated two hours and then broken directly from the oven in groups of five and four respectively, each consecu-

tive hour until the supply was exhausted. The average results are given in Table II.

No special tests were run on linen but it was observed that the regulation bone-dry tests gave trivial differences when the length of heat was varied from 1½ to 6 hours.

(*b*) Will oven-dried samples of cotton and linen return to their original strength if allowed to reabsorb moisture? To answer this question, the following procedure was carried out:

TABLE II.—EFFECT OF HEAT ON TENSILE STRENGTH OF COTTON FABRICS; OVEN TEMPERATURE 220–230° F.

Time in Oven, hr.	Average Tensile Strength, lb.	
	Woven Tire Fabric.	Two-Ply Balloon Fabric.
2	186.6	75.5
3	187.6	72.8
4	182.2	72.8
5	185.8	69.5
6	185.6	74.8
7	190.2	72.5
8	188.2	73.8
9	184.4	72.5
10	181.8	....
11	190.4	....
12	187.0	....
13	186.0	....
14	185.0	....

Cotton.—Ten samples of woven tire fabric were dried 3½ hours in the oven and then conditioned for 3 hours side by side with ten others which had never been dried. The conditioned samples gave an average tensile strength of 287.4 lb. The dried and re-conditioned samples gave an average tensile strength of 289.4 lb.

Linen.—Eight samples of Courtrai wing linen were conditioned 3 hours and tested. The average tensile strength was 99.0 lb. Seven similar samples were dried 3 hours in the oven and tested. Their average tensile strength was 67.3 lb.

Fourteen similar samples were dried 3 hours and re-conditioned for 3½ hours, then tested. Their average tensile strength was 99.0 lb. Incidentally the moisture regain was measured and found to be 7.94 per cent of the dry weight. The increase in strength due to moisture regain was therefore 31.7 lb., or 47.1 per cent of the dry strength. This corresponds to about 6 per cent increase in strength for each per cent of moisture absorption.

Balloon Fabric.—Ten samples were dried 4 hours in the oven and conditioned 6 hours side by side with ten similar samples which had never been dried. The conditioned samples gave an average strength of 105.6 lb. and the dried and re-conditioned samples 101.0 lb. A falling off of about 4 per cent in the strength is here noted.

(*c*) Can samples be transferred inside the hot oven from the baskets to stoppered weighing bottles, if handled only with steel tweezers, without sensible moisture regain? To establish this fact, several baskets of fabric were dried and weighed through the roof of the oven with the door closed. The samples were then transferred as described above to weighing bottles, allowed to cool, and reweighed. Very minute differences, due to the "uplift" of hot air currents when weighing in the oven, were noted, but in no case did they exceed 0.1 grain.

(*d*) When specimens are broken hot from the oven, what is the actual regain at the time of rupture due to the necessary interval in the air? To remove a sample from the oven with tweezers, insert it in the testing machine with reasonable care and break it takes an experienced operator an average of 18 seconds by a stop-watch. To remove the broken sample from the jaws and seal it up in a stoppered weighing bottle takes 4 seconds. In this interval of 22 seconds it was found that wing cotton had regained about 1.6 per cent, wing linen 1.9 per cent, balloon fabric 0.35 per cent, and woven tire fabric 0.45 per cent. It is evident that heavy fabrics, as well as rubberized ones, do not obtain their regain as quickly as thin wing fabrics. The room temperature in these tests was approximately 75° F. and the relative humidity 70 per cent.

(*e*) Are the lap joints in the bias-ply of balloon fabrics a source of weakness or may their presence be disregarded in

cutting and selecting samples? To investigate this question three grades of two-ply balloon fabric were selected of light, medium and heavy weight. Five specimens of each were cut with a joint in the center of each and five more adjacent ones without any joint. The thirty specimens were conditioned to uniformity and tested with the results given in Table III.

METHODS.

The humidity in the testing room was run up to a high figure. For most of the tests the temperature was 75° F. and the relative humidity 80 per cent. The samples of a given fabric were hung all at one time to the number of about 150 in the room and allowed to regain moisture for not less than 4 hours. They were then taken in groups of four or five and held in a hot oven for periods varying from 3 seconds to 20 minutes.

TABLE III.—TESTS OF JOINTS IN BALLOON FABRIC.

How Tested.	Average Strength, lb.		
	Light.	Medium.	Heavy.
With joint	90.8	100.4	103.6
Without joint	94.8	97.0	103.8

This operation graded the actual regain from a high figure practically to bone dryness. After removal from the oven the samples were placed between the leaves of a heavy book to keep the moisture as near stationary as possible until they were tested. They were broken in rapid succession, removed speedily from the machine and immediately enclosed in air-tight glass weighing bottles. The interval between breakage and sealing in the bottles was not over four seconds. Five samples of the linen and cotton were grouped as one test and weighed after breakage together. It was assumed that their humidities were all the same. For the balloon fabric four samples were grouped. Immediately after breakage the bottles and contents were weighed and the net weight of the fabric found by subtraction. The fabric was next taken from the weighing bottles and dried for not less than two hours in the oven. The fabric was transferred from the oven baskets back to the weighing

bottles inside the oven door by means of tweezers. No specimens were touched by the hands except a few of the balloon fabric. After cooling, the bottles were again weighed and the bone dry weight of the contents found by subtraction. From this the regains at the actual time of the tests were calculated in terms of the dry weight. It is believed that this method is as accurate as can be found for determining the moisture actually present at the time of breakage. For higher degrees of regain the samples were hung from 10 minutes to two hours in the wet room previously described where the relative humidity was about 95 per cent.

In the case of the woven tire fabric only one sample at a time was tested. This was first dried, then exposed to moisture in the wet room and lastly tested as above.

DISCUSSION OF RESULTS.

The results of the tests upon cotton wing, linen wing, balloon and woven tire fabrics are shown in Figs. 1, 2, 3 and 4, respectively. Their interpretation is evident. The several tests at a given humidity are denoted and their average is signified by the crossed circle.

1. *Cotton Wing Fabric.*—It was found by the above methods that it was very difficult in this thin fabric to test the samples, nominally "bone-dry," without a considerable reabsorption of moisture. About 1.5 per cent regain occurred during the interval between removal from the oven and breakage. "Full regain" in an atmosphere slightly above standard was denoted by about 8 per cent absorption. Beyond this the absorption was obtained by exposure in the wet room at 95 per cent relative humidity. The average increase in strength from the dryest obtainable to 8 per cent regain was from 58 to 72 lb., or 14 lb., about 24 per cent of the bone-dry strength. This corresponds to about 3 per cent increase in strength for each added per cent of moisture. Twenty-four sets of tests made by the classes in airplane study at the Institute upon this same kind of fabric showed an average increase of 26 per cent between bone dryness and full regain. The curvature of the plot does not take place within the region of usual regain and the line may be considered straight for all practical purposes. One

hundred and thirty-three samples were broken in this fabric and only two were cast out as indicating "flaw breaks."

2. *Wing Linen.*—The normal regain of raw flax fiber is often stated as 12.5 per cent of the dry weight. While this is doubtless true for a free condition of the material, the figures are much less for manufactured linen. Flax absorbs moisture much more quickly than cotton. Bone-dry samples tested with great dispatch regained nearly 2 per cent of moisture before breakage. The normal regain for the fabric was about 9 per cent and the strength increase from about 55 lb. to 85 lb., or 30 lb. This represents about 54 per cent of the bone dry

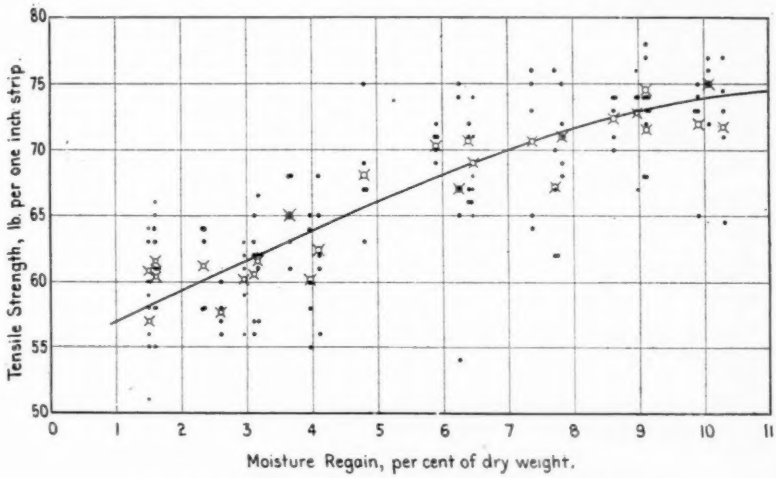

FIG. 1.—Results of Tests upon Cotton Wing Fabric.

strength, a gain of 6 per cent in strength for each added per cent of moisture. Twenty-two sets of tests made by classes in aviation showed 40 per cent increase in strength. The degree of moisture regain in these tests was not so high as those performed by the author. One hundred and twenty-three tests were made on linen and five omitted in the plot. A few were made at yet higher degrees of moisture and indicated but little increase in strength, hence the line should bend down to the horizontal as it leaves the plot

3. *Balloon Fabric.*—The effect of moisture on rubberized fabrics is unique. The moisture is very much slower naturally

in entering such material. Bone-dry tests can be conducted with an actual moisture reabsorption of less than 0.5 per cent before breakage. At low regains the moisture probably lies upon the outer surface and has but little effect upon the strength. At higher regains the moisture evidently penetrates the fiber and has a pronounced effect. From bone dryness to a full regain

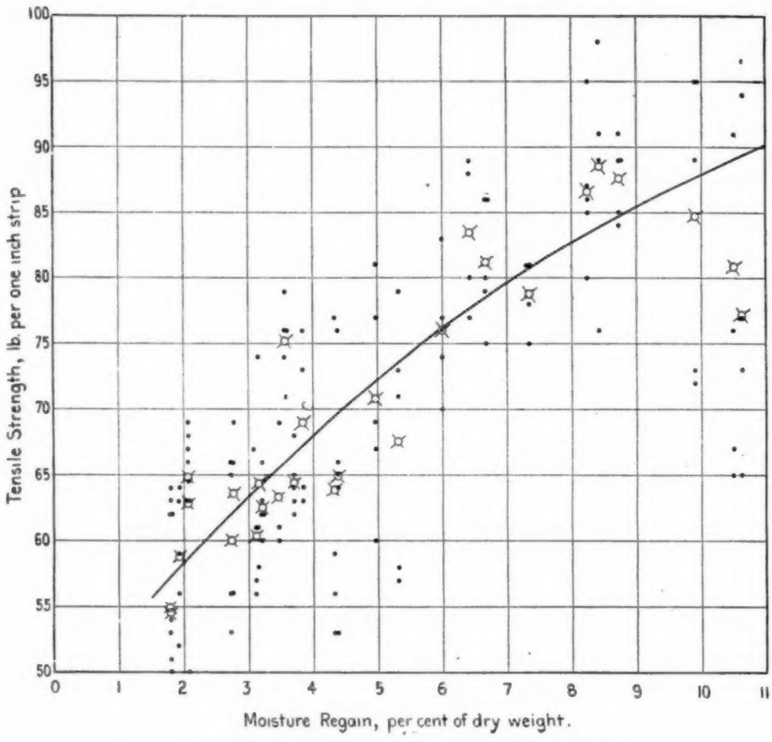

FIG. 2.—Results of Tests upon Linen Wing Fabric.

of $7\frac{1}{2}$ per cent there is an increase of from 70 to 110 lb., or 40 lb. This corresponds to about 57 per cent of the dry strength, or nearly 8 per cent increase for each added per cent of moisture. The increase is not uniform, however, as the curve indicates. One hundred and thirty-nine breaks were made and none omitted on the plot.

4. *Woven Tire Fabric.*—The term "standard regain" has generally been applied to the percentage of moisture auto-

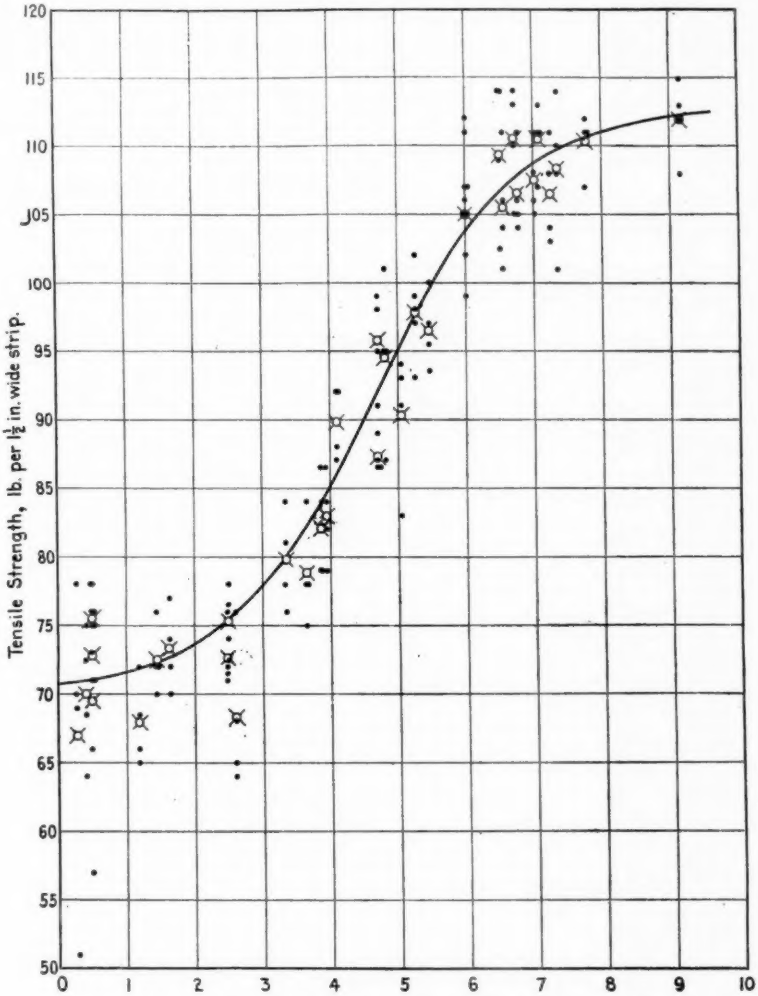

FIG. 3.—Results of Tests upon Balloon Fabric.

matically absorbed by raw cotton when exposed for a more or less lengthy period in an atmosphere at a temperature of 70° F.

and a humidity 65 per cent of saturation. This quantity has generally been stated as 8.5 per cent of the dry weight. While the above regain value is doubtless true for raw cotton exposed for long periods to high degrees of moisture, it is believed that

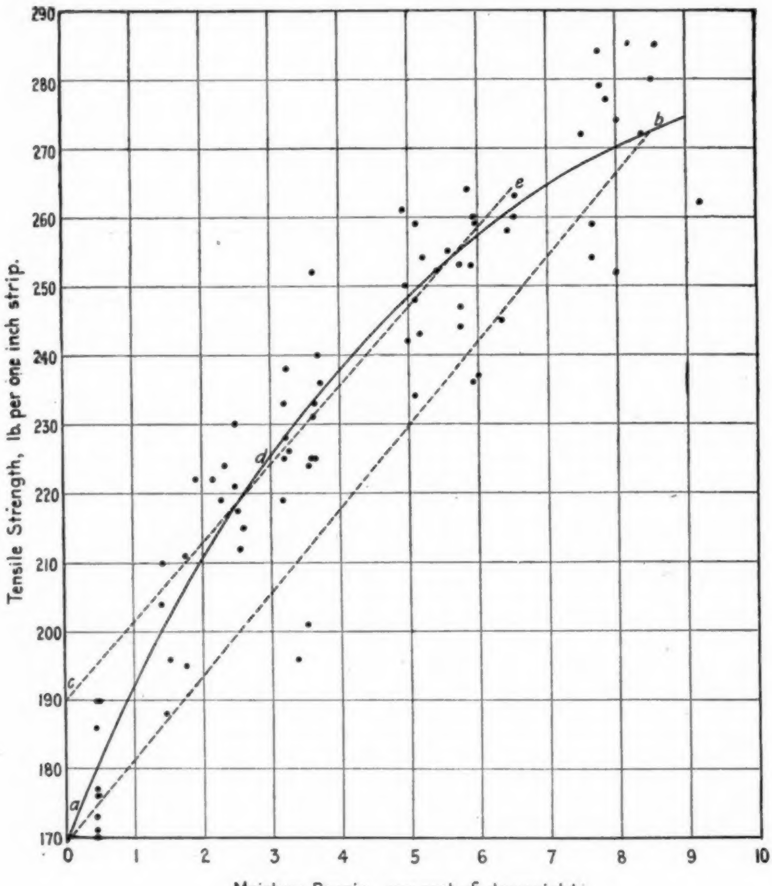

FIG. 4.—Results of Tests upon Woven Tire Fabric.

for heavy grades of manufactured cotton, where free access to the air is less perfect and especially where the regain is artificially produced by exposure of but a few hours in a "conditioning room," the value seldom exceeds 6.5 per cent of the

dry weight. It is therefore proposed by Committee D-13, from practical considerations, to define the "standard condition" of tire fabric as that at which a moisture regain of 6.5 per cent of the dry weight has been attained. Fig. 4 was the work of Messrs. Yeaton and Panettiere, performed under the author's direction in the Textile Laboratory at the Massachusetts Institute of Technology, and comprised accurate strength and regain determinations with the latter varying from zero to 9 per cent. Seventy-five warp specimens were broken and none have been cast out.

The actual increase in tensile strength with moisture

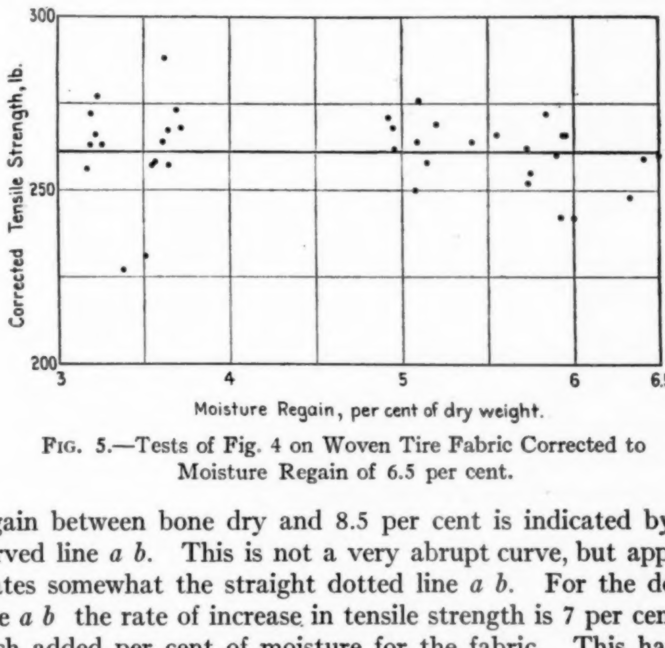

FIG. 5.—Tests of Fig. 4 on Woven Tire Fabric Corrected to Moisture Regain of 6.5 per cent.

regain between bone dry and 8.5 per cent is indicated by the curved line *a b*. This is not a very abrupt curve, but approximates somewhat the straight dotted line *a b*. For the dotted line *a b* the rate of increase in tensile strength is 7 per cent for each added per cent of moisture for the fabric. This has led some testing laboratories to adopt a method of correction for moisture regain. The samples are weighed in their natural condition and broken in rapid succession before the moisture present can change. The broken specimens are then weighed again after drying in an oven. This gives a means of computing the regain which was present at the actual time of testing. To reduce the tensile strength to a condition of com-

plete moisture regain, namely 8.5 per cent, it would be necessary first to divide the apparent strength by $100+(7\times$actual regain percentage at test), and then multiply by $100+(7\times8.5)$. This is equivalent to reducing the strength of the sample to a bone-dry condition, on the assumption of 7 per cent strength increase for each per cent of regain, and then moving it up again on the same basis to a full regain of 8.5 per cent. Thus, if a piece of tire fabric gives an apparent tensile strength of 260 lb. and was found to contain 4 per cent regain at the time, its strength corrected for full regain would be,

$$\text{Corrected Tensile Strength} = \frac{260\times[100+(7\times8.5)]}{100+(7\times4)} = 324 \text{ lb.}$$

If tire fabric could be made to move readily from the bone-dry condition to full regain, the above method would suffice and give results very approximately correct. However, as a matter of practical fact, manufactured cotton in its natural state rarely contains less than 3 nor more than 6.5 per cent regain. It has been deemed wise by the committee, therefore, to set up these arbitrary limits in order most nearly to meet working conditions. The full regain or "standard condition" has therefore been set at 6.5 per cent in the proposed tentative standards of Committee D-13.

Between the above limits of 3 and 6.5 per cent regain the strength curve is more nearly approximated by the straight line *d e*, for which the rate of increase is very nearly 6 per cent of strength for each per cent of regain. For actual working conditions, therefore, the form of the correction equation should be,

$$\text{Corrected Tensile Strength} = \frac{\text{Apparent strength}\times[100+(6\times6.5)]}{100+(6\times\text{Actual Regain at Test})}$$

It is to be borne in mind that this formula is only applicable between regains of 3 and 6.5 per cent. It will not yield the bone dry strength at *c* on the assumption of zero regain, nor will it give full regain strength on the basis of 8.5 per cent regain.

It is hoped by the committee that this method will obviate the haste and consequent inaccuracy of testing samples hot from the oven when the moisture regain and change in strength is most rapid. Also if the above method is used as recommended

it will largely eliminate the perplexity arising when the regain is either unknown or disregarded.

The mathematics of Fig. 4 are as follows: In passing from bone dry to 8.5 per cent regain the increase in strength is from 170 lb. to 274 lb., or 104 lb. This represents 61 per cent of the dry strength or about 7 per cent increase in strength for each added per cent of regain. Between bone dryness and 6.5 per cent regain the strength increases by line *c d e* from a fictitious bone-dry strength of 190 lb. to 265 lb., or 74 lb. This represents 39 per cent of the imaginary dry strength of 190 lb. Thus within this range of 6.5 per cent regain there is an increase of 6 per cent in strength for each added per cent of moisture.

Fig. 5 shows the effect of correcting all the tests of Fig. 4 by means of the above formula. The straight line is the numerical average of all the tests so corrected.

5. *Cord Fabric.*—No extended tests were made on this material. Regains were measured upon four samples of the fabric when conditioned 3½ hr. at 75° F. room temperature and 71 per cent relative humidity. They were very uniform and averaged 7.15 per cent of the dry weight.

Twenty cords were tested at full regain and gave a tensile strength of 21.8 lb. Twenty more were broken bone dry and averaged 15.5 lb. The gain of 6.3 lb. is 40.5 per cent of the dry strength. This corresponds to 5⅝ per cent increase in strength for each added per cent of moisture. Cord fabric is not then seriously different from woven tire fabric in its moisture behavior.

SUMMARY.

Whenever new materials are employed for purposes of construction, it is a prime essential that specifications and tests shall be accurately drawn and carefully carried out. The replacement of linen by cotton for the airplane wing and the general refinement of specification which has been brought about by the increased use of the aircraft has made it necessary to scrutinize the testing of fabric as never before. In the past much earnest but misdirected effort has been put forth in testing textiles, the chief difficulty being that the effect of moisture was not taken into account. To obviate this difficulty, Com-

mittee D-13 on Textile Materials, of this Society, has devoted much time of late to a discussion of the best method of dealing with moisture in fabrics. As a basis for this discussion, it is absolutely necessary that carefully performed experiments shall be carried out to show the exact increase in tensile strength with added percentages of moisture. In this line the author of this paper has sought to record an extended series of experiments performed in the Textile Testing Laboratory of the Institute of Technology.

Heavy fabrics of cotton, such as tire duck, were found to gain about 7 per cent of the dry strength for each added per cent of moisture and the same figures held practically for wing linen. Light cotton fabrics were found to gain about 3 per cent for each added per cent of moisture. Balloon fabric, a rubberized plied cloth, naturally had a behavior peculiar to itself, but exhibited the same general increase in strength. Cord fabric for tires was found to follow practically the laws of woven fabric for the same purposes.

REPORT OF COMMITTEE E-1
ON
METHODS OF TESTING.

Committee E-1 has held two meetings since the last annual meeting of the Society.

The committee has under consideration a number of subjects, most of which are still in the hands of sub-committees. It is prepared, however, to report finally on the Speed of Testing, and it recommends for adoption as standard by the Society the revisions in the Standard Methods of Testing (E 1–16) relating to speed of testing proposed by the committee last year.[1] These revisions are repeated for convenient reference in Appendix I.

This recommendation has been referred to letter ballot of the committee, which consists of 33 members, of whom 23 have voted affirmatively, none negatively, and 10 have refrained from voting.

The committee also submits to the Society the following Report on the "Effect of Form and Size of Tension Test Pieces on the Results of Tests":

Under the auspices of a sub-committee, a series of tests and a study of existing test data have been made. A summary of these test data is given in Appendix II to this report, in the form of a paper by Mr. H. F. Moore, the chairman of the sub-committee. As a result of the investigations thus far, the committee sees no ground for recommending changes in the design of the present tension test specimens.

However, in the case of specimens from forgings and castings, it has been forcibly brought out that it is frequently not convenient, and sometimes impossible, to obtain them as large as the standard, namely, 2 by $\frac{1}{2}$-in. round specimens as at present required.

It may be necessary, not only to modify the dimensions in order to provide smaller round specimens, but in some cases, owing to the peculiar shape or thin walls of the object tested, rectangular specimens may be required. Under these conditions

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 499–501 (1917).

the committee would recommend that they should be of such dimensions that the law of similarity may be observed. This can be expressed

$$\frac{l}{\sqrt{a}}=K$$

in which l = the gage length of the specimen, a = its area of cross-section, and K = a constant.

For the standard A.S.T.M. 2 by ½-in. round specimen this formula becomes

$$\frac{l}{\sqrt{a}}=4.5.$$

It is recommended that it be used to govern the dimensions of tension test specimens other than the A.S.T.M. standard test specimens.

At the present time, based on this formula, the following sizes are in actual use:

	Cross-Section, in.	Gage Length, in.
Flat Bar	0.3 by 0.667	2
Flat Bar	0.2 " 0.5	1.4
Round Bar	0.357 diameter	1.4

The committee recommends that the attention of chairmen of the standing committees be called to these modified test specimens, in order that their use may be authorized where special conditions warrant.

This report has been referred to letter ballot of the committee, which consists of 33 members, of whom 22 have voted affirmatively, none negatively, and 11 have refrained from voting.

Respectfully submitted on behalf of the committee,

GAETANO LANZA,
Chairman.

EDITORIAL NOTE.

The proposed revisions in the standard method referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on August 26, 1918. The methods as thus revised appear in the 1918 Book of A.S.T.M. Standards.

APPENDIX I.

PROPOSED REVISIONS
IN THE
STANDARD METHODS OF TESTING.

The following revisions in the Standard Methods of Testing (E 1–16), proposed by Committee E-1 last year,[1] are recommended for adoption as standard:

1. *Section 5.*—Change from its present form, namely:

> "5. All information obtained confirms the investigations of Committee O (since dissolved), to the effect that within the limits of speed common in commercial testing, the effect of different speeds on results is not of observable moment; that is, within ranges of speed varying from 1 to 6 in. per minute.",

to read:

> "5. The pulling speed has a marked influence on the tensile properties shown by materials tested, an increase in speed increasing the values found for yield point and tensile strength. In testing steel and wrought iron in gage lengths of 2 and 8 in. in accordance with the specifications of the American Society for Testing Materials, the speed of the machine, by which is meant the speed of the crosshead when the machine is running idle, shall conform to the following requirements:
>
> "The crosshead speed of the testing machine shall be such that the beam of the machine can be kept balanced, but in no case shall the values given in the following table be exceeded:

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, pp. 499-501 (1917)

Specified Minimum Tensile Strength of Material, lb. per sq. in.	Gage Length, in.	Maximum Crosshead Speed, in. per minute, in Determining: Yield Point.	Tensile Strength.
80 000 or under	2	0.50	2.0
	8	2.00	6.0
Over 80 000	2	0.25	1.0
	8	0.50	2.0

2. *Section 6.*—Change from its present form, namely:

"6. Beyond these limits, however, very rapid loading influences the ultimate strength, which increases with the speed. Whether the elongation is increased or decreased depends somewhat upon the nature of the material, though in general, very rapidly applied loads will increase the stretch, owing to the elongation occurring over the whole body of the specimen, rather than chiefly at the point of reduction, which is more marked with slowly applied loads.",

to read:

"6. In determining the elastic limit (so-called) by the method prescribed in the American Society for Testing Materials Specifications for forgings and cold-rolled axles (Serial Designations: A 18, A 19, A 63 and A 22),[1] the crosshead speed for the 2-in. gage length shall not exceed 0.125 in. per minute."

3. *Section 7.*—Change from its present form, namely:

"7. Within the limits of speed customary in determining the modulus of elasticity, it does not appear that the rate of loading influences the value obtained, but whether this value be determined by an autographic attachment to the machine, or by an extensometer on the specimen, it is desirable that the loading be not too rapid, or not over 0.05 in. per minute, to avoid impairing the accuracy of the sensitive devices employed.",

to read:

"7. In determining the proportional limit, the crosshead speed shall not exceed 0.025 in. per inch of gage length per minute."

[1] See 1916 Book of A.S.T.M. Standards.

APPENDIX II.

TENSION TESTS OF STEEL WITH TEST SPECIMENS OF VARIOUS SIZE AND FORM.

By H. F. Moore.

(Under the Auspices of the Sub-Committee on Effect of Size and Form of Test Specimens.)

In the fall of 1916 there was organized a sub-committee of Committee E-1 of this Society, to which sub-committee was assigned the study of the effect of size and form of tension test specimen on the results of a tension test. Under the auspices of that sub-committee the study has been carried out along two lines: (1) the investigation of available test data on the subject, and (2) a series of tension tests of various grades of steel using specimens of varying size and form. The report of this sub-committee, embodying recommendations as to proportion of test specimen, is presented elsewhere; at the request of Committee E-1 the writer has prepared this paper giving a summary of the test data studied, both the test data of other experimenters, and the test data of the tests made especially for this sub-committee in the Materials Testing Laboratory of the University of Illinois.

I. Summary of Available Test Data.

List of References.—The list of references at the end of this paper gives the sources of test data which were found to be available.

Form and Size of Test Specimen; Nomenclature.—The three variables in form and size of test specimen studied comprised: (1) Variations in shape of cross-section, (2) variations in ends of specimen and in manner of gripping, and (3) variations in ratio of gage length of specimen to area of cross-section. The first two variables are qualitative; they will be discussed in

succeeding paragraphs: the third variable is quantitative. In studying this third variable the ratio of gage length to square root of area of cross-section will be called the "slenderness" of the specimen, and it will be denoted by $l/\sqrt{a}$. For plotting of results of tests it is convenient to use the reciprocal of this ratio, $\sqrt{a}/l$. Table I gives values of $l/\sqrt{a}$ and $\sqrt{a}/l$ for various test specimens in common use.

Summary of Results of Previous Tests.—Figs. 1 to 4, inclusive, give graphically the results of previous tests, and show the effect of variation of $\sqrt{a}/l$ on the results of tension tests. Fig. 1 shows the variation of yield point with $\sqrt{a}/l$; Fig. 2, the variation of tensile strength with $\sqrt{a}/l$; Fig. 3, the variation of reduction

TABLE I.—DIMENSIONS AND PROPORTIONS OF TENSION TEST SPECIMENS IN COMMON USE.

Specimen.	Gage Length, l.	Cross-Section.	$l/\sqrt{a}$	$\sqrt{a}/l$
A.S.T.M. Standard Round	2 in.	0.500 in. diameter	4.52	0.222
British, Short, Round	2 in.	0.564 in. diameter	4.00	0.250
French, Round	100 mm.	13.8 mm. diameter	8.17	0.122
German, Round	200 mm.	20 mm. diameter	11.3	0.089
Flat	8 in.	1.5 by 0.25 in.	13.05	0.077
Flat	8 in.	1.5 by 0.75 in.	7.54	0.132

of area with $\sqrt{a}/l$; and Fig. 4, the variation of elongation with $\sqrt{a}/l$. These results are discussed with the results of the tests made under the auspices of the sub-committee in a succeeding paragraph.

II. SPECIAL TENSION TESTS OF STEEL.

Specimens Tested.—In the series of tests made under the auspices of the sub-committee, tests were made on specimens of four grades of steel: (1) Rivet steel, (2) steel with about 0.35 per cent carbon content, (3) steel with about 0.56 per cent carbon content, and (4) heat-treated chrome-nickel steel. Tests were made (1) on specimens held by means of shouldered ends, (2) on specimens held by means of threaded ends, (3) on

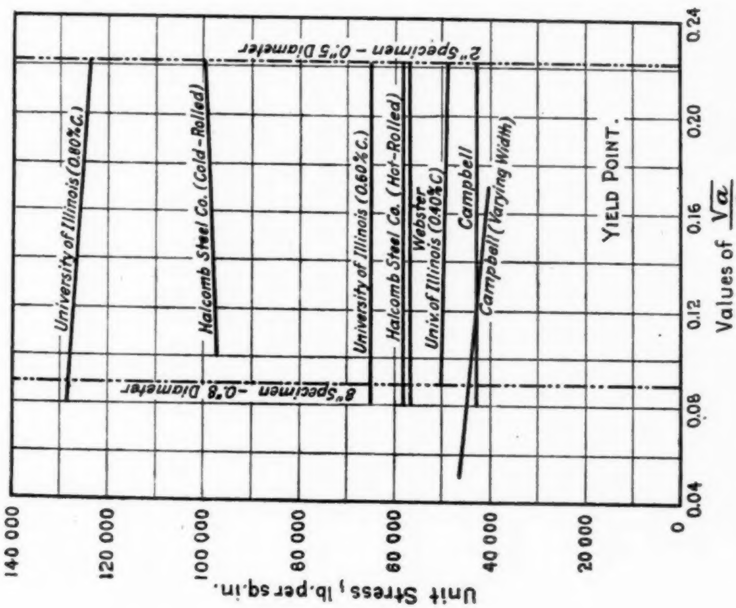

FIG. 1.—Results of Previous Tests—Yield Point.

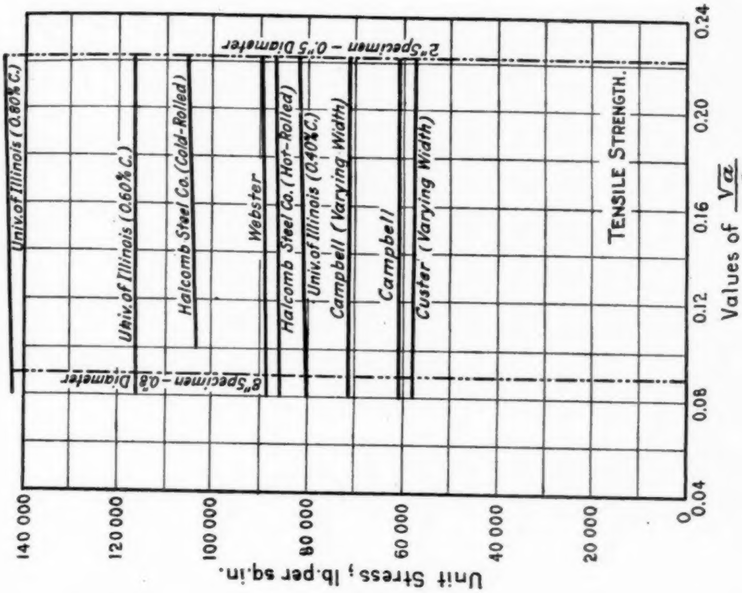

FIG. 2.—Results of Previous Tests—Tensile Strength.

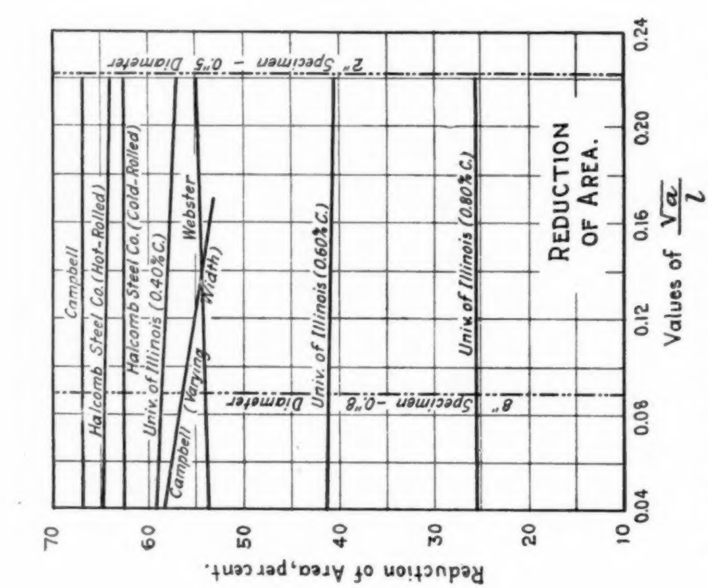

FIG. 3.—Results of Previous Tests—Reduction of Area.

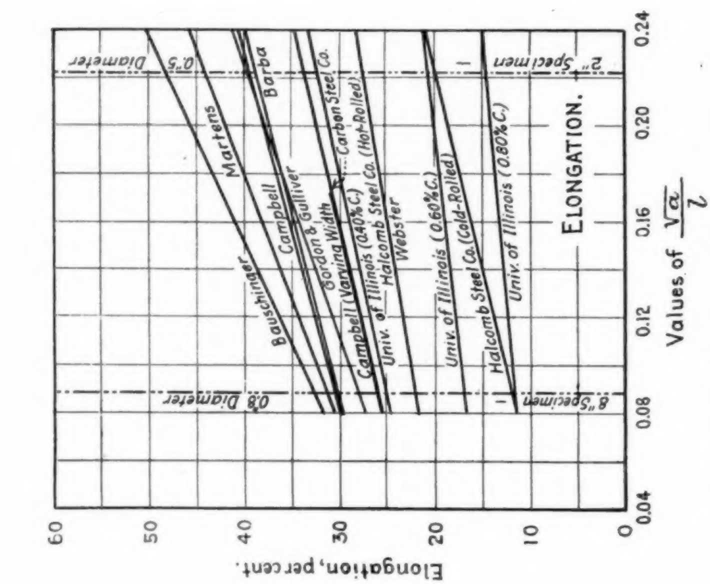

FIG. 4.—Results of Previous Tests—Elongation.

specimens with turned-down center portion and ends held by means of wedge grips, and (4) on specimens in the form of straight round rods. For the heat-treated chrome-nickel steel no specimens held by wedge grips and no specimens in the form of straight rods were tested. Fig. 5 shows the forms of specimens. Table II gives the dimensions and proportions of the specimens.

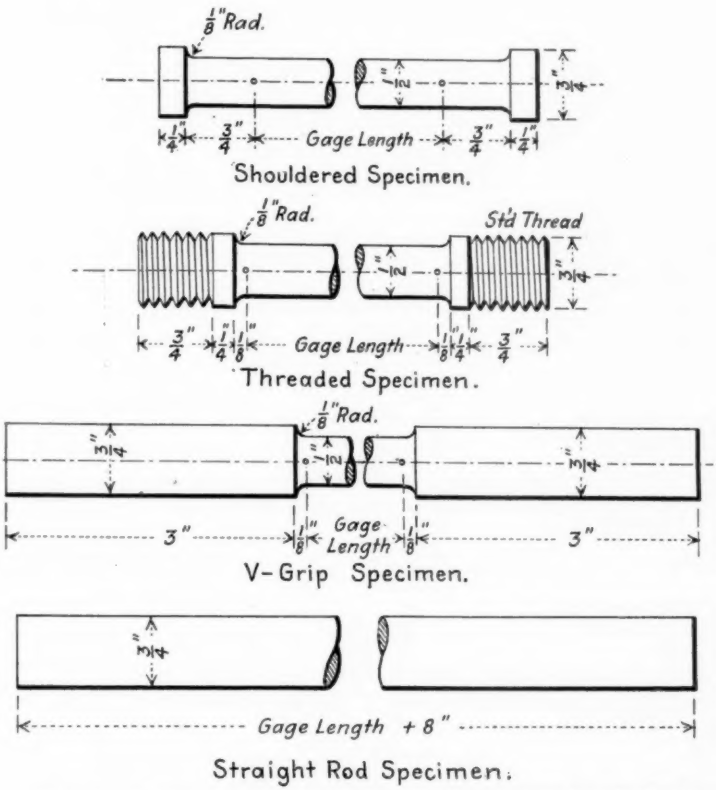

FIG. 5.—Forms of Test Specimens Used in Sub-Committee's Tests.

Tests were made in triplicate; in all, 126 specimens were tested.

Routine of Tests.—All the specimens were tested in a 100,000-lb. Riehlé testing machine, whose heads were in good alignment. An extensometer with a 2-in. gage length was used, and during the progress of a test the following observations were

made: (1) Load when the pointer of the extensometer dial showed a marked acceleration of motion (this is the method of determining "elastic limit" recommended by Committee A-1 on Steel and adopted for certain steel specifications by this Society[1]. The unit stress corresponding to this load will be called the "A-1 Elastic Limit"); (2) load at the yield point as shown by the "drop of the beam"; (3) load at the yield point as shown by the "visible stretch" of the specimen (this "visible stretch" was

TABLE II.—DIMENSIONS AND PROPORTIONS OF TENSION TEST SPECIMENS USED IN SUB-COMMITTEE'S TESTS.

Specimen.	Gage Length, l, in.	Diameter of Cross-Section, in.	$l/\sqrt{a}$	$\sqrt{a}/l$
Specimens with—				
Shouldered ends..	2	0.500	4.52	0.222
Threaded ends...	4	0.500	9.04	0.111
V-grip ends......	6	0.500	13.56	0.072
Specimens tested as straight pieces of rod........	2	0.750	3.00	0.333
	4	0.750	6.00	0.167
	8	0.750	12.00	0.083

taken as a stretch of 0.01 in. in a 2-in. gage length, as shown by the extensometer); and (4) load at the ultimate strength, which will be referred to as the "tensile strength." In making a test a semi-autographic apparatus was used like the one described by the writer in a paper to the Society last year.[2] After the yield point was passed the extensometer was removed, and a pointer and scale fastened to the specimen. This pointer and scale measured the stretch of the specimen directly, and by their use the semi-autographic diagram was drawn for the remainder of the test

[1] See 1916 Book of A.S.T.M. Standards, p. 144.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part II, p. 590 (1917).

beyond the yield point. Fig. 6 shows a typical test diagram. From a test diagram there were determined the load at the proportional limit, the load at "Johnson's Apparent Elastic Limit,"[1] the load at the "Useful Limit Point,"[2] and the stretch at maximum load. After fracture there were measured the

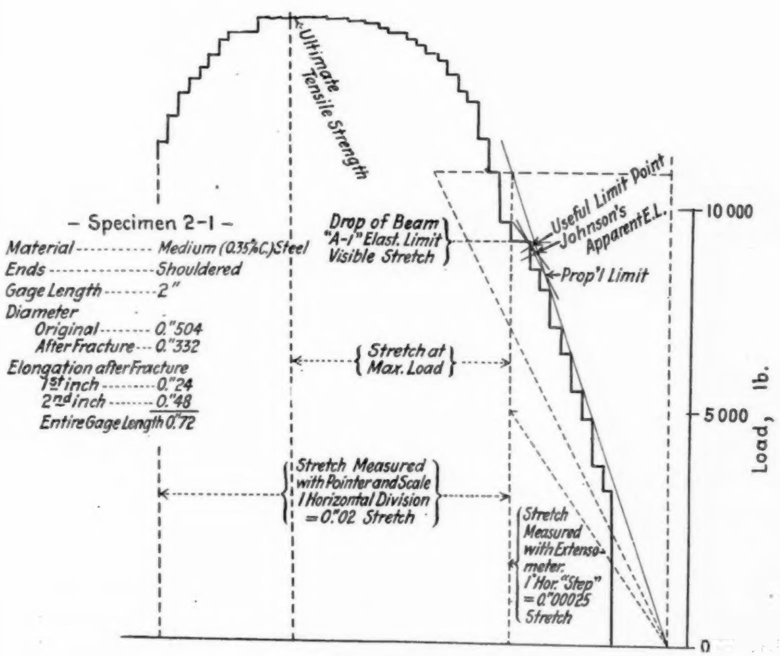

FIG. 6.—Typical Test Diagram.

elongation of each inch of gage length of specimen, the elongation over the whole gage length, and the reduced diameter at fracture.

[1] Johnson's apparent elastic limit is located by the point of tangency to the stress-strain diagram of a straight line having an inclination to the stress-axis 50 per cent greater than the straight line representing the elastic portion of the test. See J. B. Johnson's "Materials of Construction," p. 18.

[2] The useful limit point, proposed by the U. S. Bureau of Standards in connection with tests of column material, is located by the point of tangency to the stress-strain diagram of a straight line having an inclination to the strain-axis one-half as great as the straight line representing the elastic portion of the test. See *Proceedings*, Am. Soc. C. E., January 16, 1918.

From the test data thus obtained the following results were computed for each test:

Unit stress at
- Proportional limit;
- Johnson's apparent elastic limit;
- Useful limit point;
- A-1 elastic limit;
- Yield point by drop of beam;
- Yield point by visible stretch;
- Ultimate Load;

Percentage of elongation at maximum load;
Percentage of elongation after fracture;
Percentage of reduction of area at fracture.

Figs. 7 to 16, inclusive, show graphically the average results of the tests. Complete data of the tests are on file at the Materials Testing Laboratory of the University of Illinois.

III. RESULTS AND CONCLUSIONS.

Effect of Shape of Cross-Section of Specimen; Round Specimens and Flat Specimens.—The study of the effect of shape of cross-section was confined to the test data of previous tests (see Figs. 1 to 4 inclusive). The only shapes of cross-section of tension test specimens which are used in testing are rounds and flats. From the tests of Bauschinger and Barba it seems that the shape of cross-section does not markedly affect any of the results of a tension test.

From the tests of Campbell some difference was noted between the test results for $\frac{3}{4}$-in. rounds and for flat specimens of the same material with a cross-section of 2 by $\frac{3}{8}$ in. The tensile strength for the rounds averaged 2.7 per cent higher than that for the flats, and the maximum variation was 10.0 per cent. The reduction of area for the rounds averaged 4.1 per cent lower than the reduction of area for the flats. The elongation for the flats averaged 6.5 per cent more than for the rounds, but this difference is just about the difference which corresponds to the difference between the rounds and the flats in the ratios of the square root of the area to the gage length, $\sqrt{a}/l$. This will be discussed later.

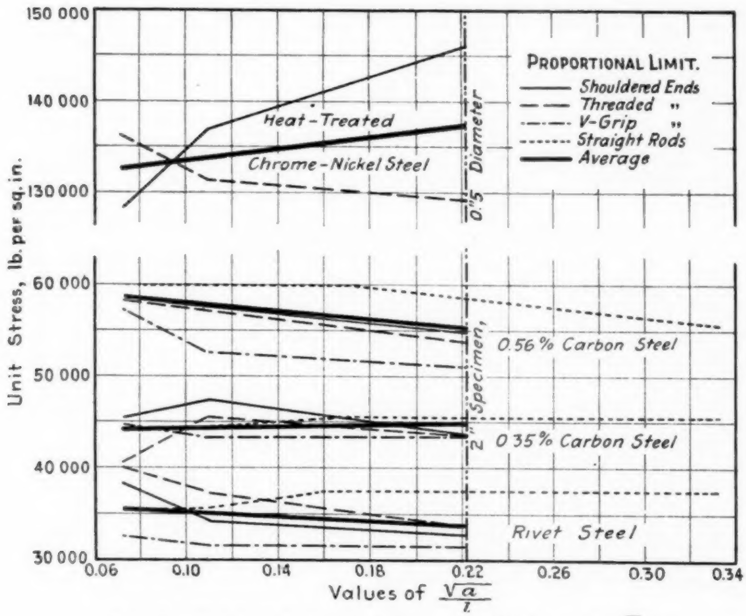

FIG. 7.—Relation between Proportional Limit and $\sqrt{a}/l$

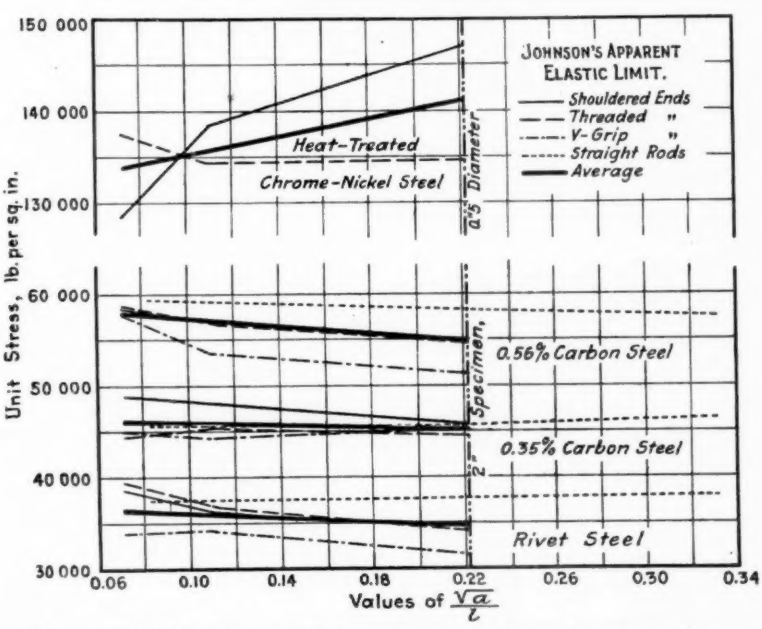

FIG. 8.—Relation between Johnson's Apparent Elastic Limit and $\sqrt{a}/l$.

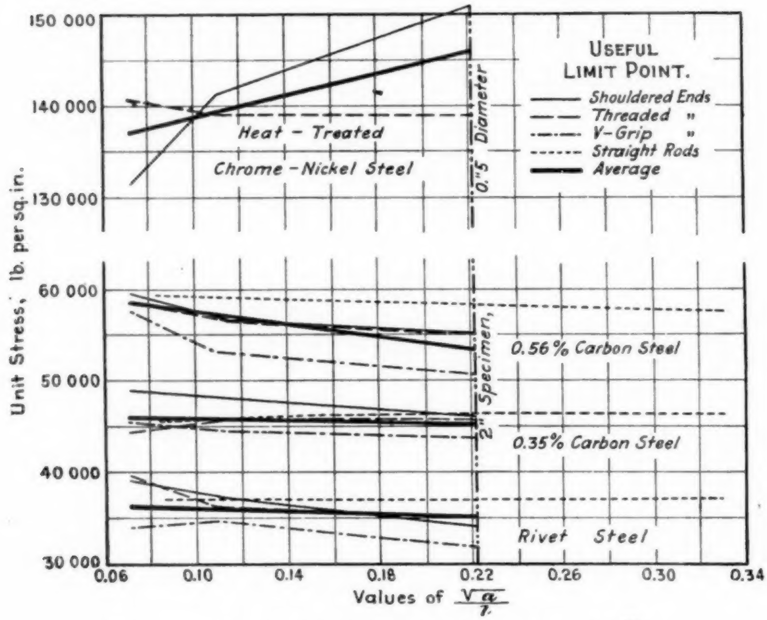

FIG. 9.—Relation between Useful Limit Point and $\sqrt{a}/l$.

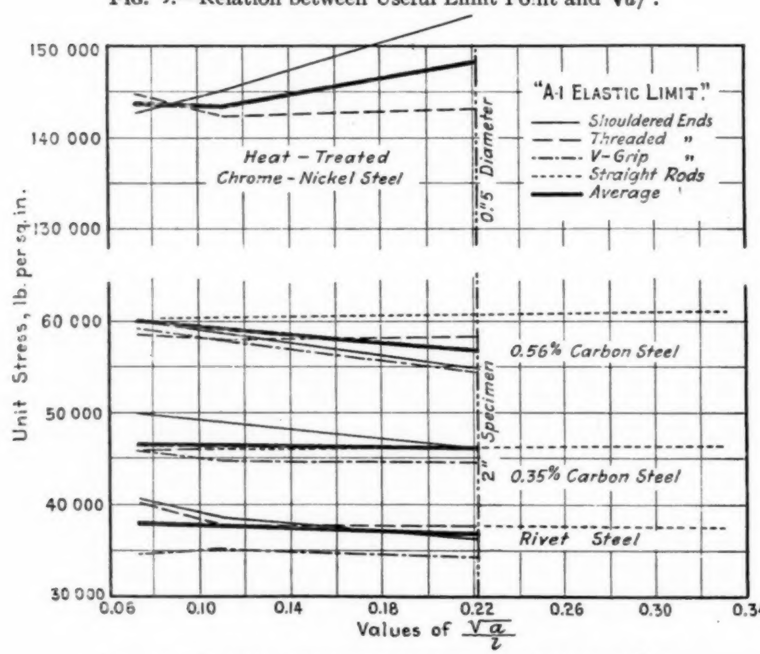

FIG. 10.—Relation between "A-1" Elastic Limit and $\sqrt{a}/l$.

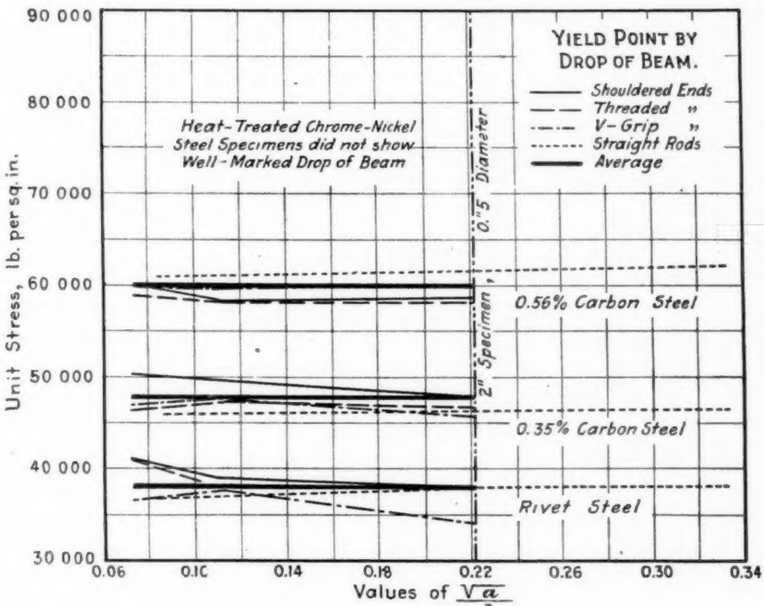

FIG. 11.—Relation between Yield Point (by Drop of Beam) and $\sqrt{a}/l$.

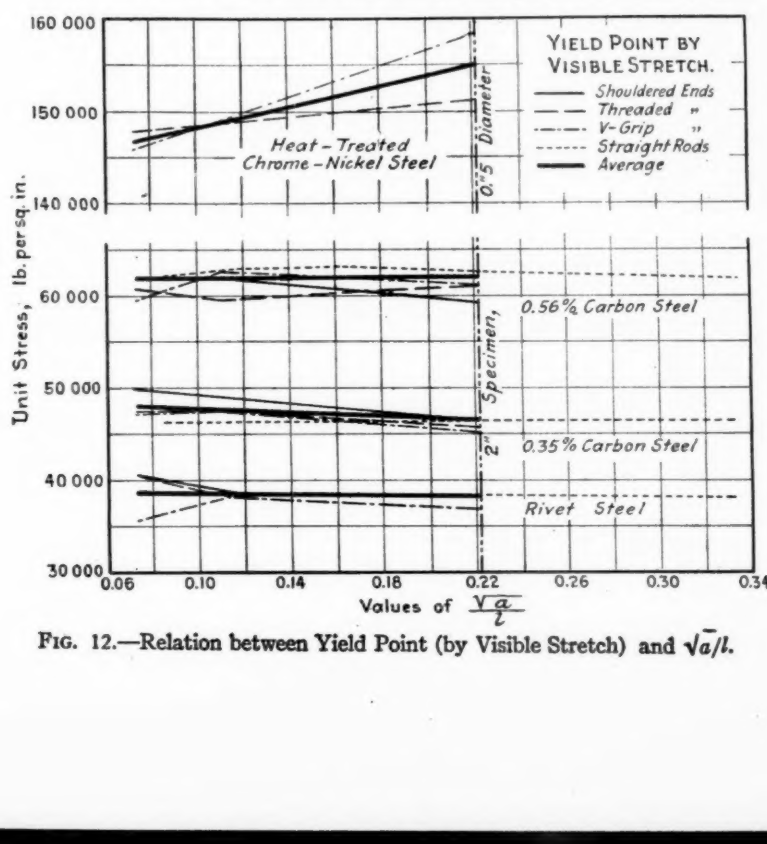

FIG. 12.—Relation between Yield Point (by Visible Stretch) and $\sqrt{a}/l$.

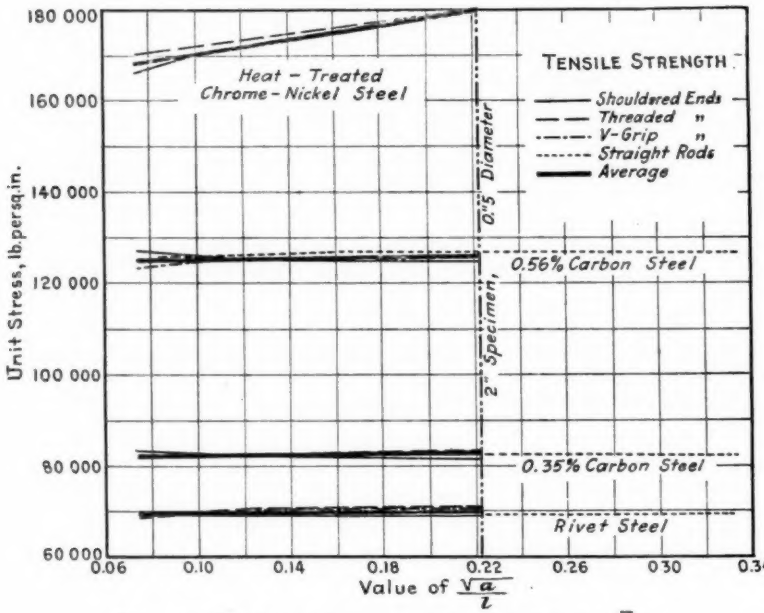

FIG. 13.—Relation between Tensile Strength and $\sqrt{a}/l$.

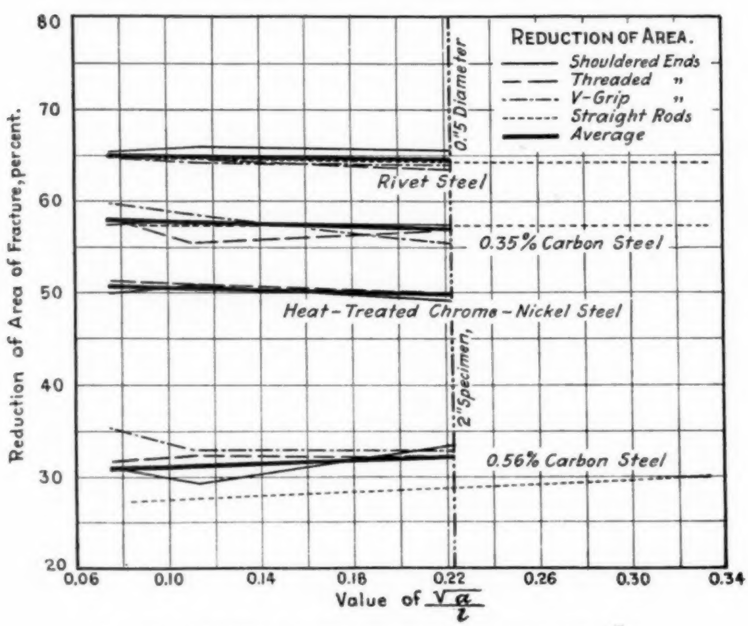

FIG 14.—Relation between Reduction of Area and $\sqrt{a}/l$.

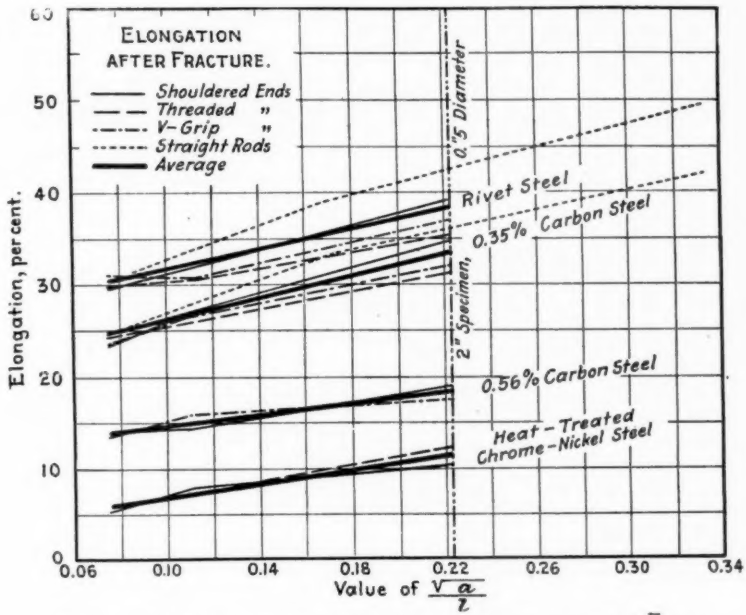

FIG. 15.—Relation between Elongation after Fracture and $\sqrt{a}/l$.

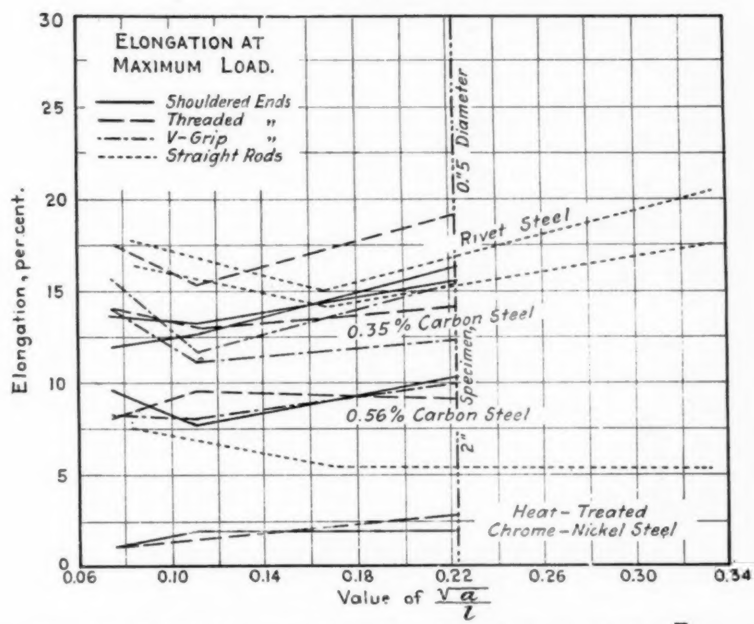

FIG. 16.—Relation between Elongation at Maximum Load and $\sqrt{a}/l$.

In view of the fact that Campbell's tests on flat specimens were made on specimens whose width was 5.3 times the thickness, in view of the small differences in values obtained for the two kinds of specimen, and in view of the results of the tests of Barba and Bauschinger, it would seem a safe conclusion that there is no great difference in results between tests made on round specimens and tests made on flat specimens whose width is not more than four times the thickness (Gordon and Gulliver suggest *three* as the limiting ratio).

Effect of Head of Specimen and Method of Gripping.—Very few data were found in the records of previous tests concerning the effect of different ends on the specimens or of the method of gripping. The sub-committee's series of tests yielded some

TABLE III.—EFFECT OF DIFFERENT ENDS OF TEST SPECIMENS.

AVERAGE DEVIATION OF AN INDIVIDUAL TEST RESULT FROM THE MEAN VALUE, EXPRESSED IN PER CENT OF THE MEAN VALUE.

Specimen.	Proportional Limit.	Johnson's Apparent Elastic Limit.	Useful Limit Point.	"A-1" Elastic Limit.	Yield Point.		Tensile Strength.	Elongation after Fracture.	Reduction of Area.
					Drop of Beam.	Visible Stretch.			
Shouldered ends..	2.85	2.56	2.43	1.63	1.52	1.36	0.92	3.98	1.22
Threaded ends....	3.19	3.25	2.91	2.32	2.34	2.12	0.62	3.55	2.54
V-grip ends......	2.86	2.87	2.64	2.72	2.45	2.06	0.51	2.39	2.27
Straight rod......	2.56	1.81	1.50	1.30	1.80	1.34	0.92	1.36	1.88

data on this subject. In general the test results showed no very marked advantage of one type of specimen over another, or any systematic difference in test results due to difference in ends or methods of gripping. To study the uniformity of results obtained for the different types of specimen the following procedure was used: The specimens were tested in groups of three, the results for each group were averaged, and the deviation of each individual test from this average (expressed in per cent of each mean result) was determined and tabulated. These deviations in the determination of the proportional limit, Johnson's apparent elastic limit, the useful limit point, the "A-1 elastic limit," the yield point, and the tensile strength were averaged for each type of specimen (shouldered, threaded-end, V-grip, and straight rod) and the results shown in Table III.

It was found in carrying on the tests that the specimens with shoulders or with threaded ends were handled more readily than were the specimens held in V-grips.

Effect of $\sqrt{a}/l$ on the Various "Elastic Limits," Yield Point, and Tensile Strength.—Both from the data of previous tests and from the data of the sub-committee's tests the effect of variation of $\sqrt{a}/l$ on the above properties is seen, in general, to be slight. Two exceptions to this are: the cold-drawn steel tested by the Halcomb Steel Co., and the heat-treated chrome-nickel steel tested in the sub-committee's tests. For both of these the reduction of area was relatively high, and the shorter test specimens showed increased values for strength. The probable

TABLE IV.—EFFECT OF VARYING LENGTH OF TEST SPECIMENS ($\frac{1}{2}$-IN. SPECIMENS ONLY).

AVERAGE DEVIATION OF AN INDIVIDUAL TEST RESULT FROM THE MEAN VALUE, EXPRESSED IN PER CENT OF THE MEAN VALUE.

Gage Length, in.	Proportional Limit.	Johnson's Apparent Elastic Limit.	Useful Limit Point.	"A-1" Elastic Limit.	Yield Point.		Tensile Strength.	Elongation after Fracture.	Reduction of Area.
					Drop of Beam.	Visible Stretch.			
2...........	2.68	2.69	2.61	2.10	2.23	1.63	0.92	2.98	2.12
4...........	2.04	2.54	2.25	2.15	1.94	1.90	0.52	3.72	1.85
6...........	4.17	3.45	2.82	2.29	2.02	1.95	0.64	3.45	1.99

explanation of this action is that the enlarged ends tend to restrain the natural lateral contraction under axial tension, and hence to decrease the axial stretch and give higher loads for failure of the specimen. For longer specimens this effect would be less, and for material of high strength and large reduction of area the effect would be marked, and the test results are in accord with these statements. In this connection it should be noted that Martens in the "Handbook of Testing Materials" gives a lengthy discussion of this point, and that Kirkaldy found that the tensile strength of specimens in which the turned-down portion was merely a semi-circular groove was abnormally high; such specimens showed very little contraction of area.

If the effect of the ends were negligible for the longer specimens the line showing the relation of strength qualities to $\sqrt{a}/l$ would be horizontal for low values of $\sqrt{a}/l$ (long specimens).

An examination of Figs. 1 and 2, and 7 to 13, inclusive, shows that neither for cold-drawn steel nor for chrome-nickel steel does the line become horizontal for the specimens tested. Even for the longer specimens tested the ends seem to have some effect on the strength.

The uniformity of results for specimens of different lengths was studied by means of a tabulation of deviations of individual test results from mean result, made in a manner similar to that described under "Effect of Head of Specimen and Method of Gripping," and the average deviations for different length specimens are given in Table IV. No greater uniformity is shown by long specimens than by short specimens.

Effect of $\sqrt{a}/l$ on Reduction of Area.—All the test data indicate that the reduction of area at fracture is very slightly affected by the value of $\sqrt{a}/l$ for a specimen, and that such variations as are shown are sometimes in one direction, and sometimes in the other.

Effect of $\sqrt{a}/l$ on Elongation after Fracture.—All the test data show that the effect of variation of $\sqrt{a}/l$ on the percentage of elongation after fracture is very pronounced. Within the limits of $\sqrt{a}/l$ for ordinary test specimens (from 0.07 to 0.250) the test data when plotted show a straight-line relation between elongation and values of $\sqrt{a}/l$ for specimens of the same material. This is in accord with the equation proposed by Bauschinger:

$$e = e_o + Q\frac{\sqrt{a}}{l},$$

in which e = the elongation measured in per cent of gage length for a specimen with gage length l and area of cross-section a;

e_o = the elongation of a specimen with a value of $\sqrt{a}/l$ equal to zero (length equal to infinity); and

Q = a constant to be determined experimentally.

Another way of expressing this same relation is to compare the elongation of a specimen with that of a specimen of the same material with gage length of 2 in. and diameter of 0.5 in. ($\sqrt{a}/l = 0.222$). Denoting the elongation of such a specimen by e_2, we may write

$$e = e_2 - Q'(0.222 - \sqrt{a}/l).$$

The constant Q' is a measure of the rate of change in the value of e for any given value of $\sqrt{a}/l$. No general relation was discovered between values of the constant Q' and the elongation of the standard 2-in. test specimen. The tests gave for values of Q':

Soft rivet steel	53.6
0.35-per-cent carbon steel	58.6
0.56-per-cent carbon steel	31.4
Heat-treated chrome-nickel steel	36.9

Elongation at Maximum Load.—It has been proposed to use

TABLE V.—AVERAGE ELASTIC LIMITS AND YIELD POINTS DETERMINED BY DIFFERENT METHODS.

Property Determined.	Rivet Steel.	Steel with 0.35-per-cent Carbon.	Steel with 0.56-per-cent Carbon.	Heat-treated Chrome-Nickel Steel.
Proportional limit	35 200	44 200	55 900	134 600
Johnson's apparent elastic limit	35 600	45 300	56 100	136 400
Useful limit point	36 300	45 600	57 100	140 300
"A-1" elastic limit	37 400	46 300	58 500	145 500
Yield point by drop of beam	37 600	46 500	59 400[a]	..... [a]
Yield point by visible stretch	38 000	46 500	60 600	149 500
Tensile strength	59 700	72 500	115 700	163 500

[a] Yield point not very sharply determined by drop of beam.

the percentage of elongation at maximum load as an index of ductility in place of the elongation after fracture on the ground that the elongation at maximum load is a general elongation of the specimen, while the elongation after fracture depends largely on the local elongation near the plane of fracture. The instant of maximum load, however, is not at all well marked for specimens of ductile materials, and even when an autographic diagram of the test is available the determination is not very certain. Moreover, the elongation at maximum load depends somewhat on the nearness of the plane of fracture to the end of the specimen. Fig. 16 shows the average results for elongation at maximum load, and it can be readily seen that the results are lacking in uniformity.

Various Methods of Determining "Elastic Limit" and Yield Point.—It has frequently been pointed out that various methods of determining "elastic limit" and yield point were in use, and that different methods gave different values. Not all known methods were used in the sub-committee tests (thus, no methods were used involving measurement of permanent set), but a number of methods were used, and the results given by various methods are shown in Tables V and VI. Table V gives the average values for various "limits" showing the range covered, and Table VI gives values of the average deviation of a single

TABLE VI.—UNIFORMITY OF ELASTIC LIMITS AND YIELD POINTS DETERMINED BY DIFFERENT METHODS.

AVERAGE DEVIATION OF AN INDIVIDUAL TEST RESULT FROM THE MEAN VALUE, EXPRESSED IN PER CENT OF THE MEAN VALUE.

Kind of Steel.	Proportional Limit.	Johnson's Apparent Elastic Limit.	Useful Limit Point.	"A 1" Elastic Limit.	Yield Point.		Tensile Strength.
					Drop of Beam.	Visible Stretch.	
Rivet steel	3.17	2.98	2.57	2.92	2.64	1.96	0.68
Steel with 0.35-per-cent carbon	2.55	2.12	1.89	1.53	1.56	1.56	0.74
Steel with 0.56-per-cent carbon	2.62	2.50	2.35	1.54	1.68[a]	1.63	0.78
Heat-treated chrome-nickel steel	3.52	3.41	2.69	2.02	....[a]	1.81	1.33
General Average	2.96	2.76	2.38	2.00	1.96[a]	1.74	0.76

[a] Drop of beam not clearly defined with high-carbon and alloy steels.

determination from the mean result for different "limits." The manner of determining the average deviation of an individual result is similar to that described under "Effect of Head of Specimen and Method of Gripping." As the different "limits" were all determined for the same set of specimens this comparison of average deviations of individual test results is believed to be of some value as an index of the reliability of the various methods used. The comparatively high uniformity of results given by the observation of a "visible stretch" (of 0.01 in.) and by the method suggested by Committee A-1 seem worthy of note. In view of the fact that for very strong steel a stretch of 0.01 in. might take place in a 2-in. gage length before any appreciable inelastic action had occurred would limit the usefulness of the "visible stretch" method of determining yield point.

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REPORT OF COMMITTEE E-3

ON

REVISION OF PIPE THREADS.

FORMING PART OF A JOINT COMMITTEE WITH COMMITTEES OF THE FOLLOWING SOCIETIES:

AMERICAN GAS INSTITUTE.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
MANUFACTURERS' ASSOCIATION ON STANDARDIZATION OF FITTINGS.
MASTER CAR BUILDERS' ASSOCIATION.
RAILWAY SIGNAL ASSOCIATION.

The work of this committee originated in March, 1913, when the Sub-Committee on Tubes of Committee A-1 was charged with the duty of writing a specification for pipes. It was then suggested that the sub-committee consider the advisability of revising the pipe thread standard with a view of prolonging the life and service of pipes, particularly pipes subject to vibration. At the present time the Briggs Standard thread is used, which is a sharp "V" angular thread. In June, 1913, a sub-committee was appointed to collect data regarding pipe failures. It was also decided to make tests showing the comparative strength of the Briggs and Whitworth threads. The work of these sub-committees was duly reported at various meetings of Committee A-1.

In January, 1915, the Executive Committee appointed a new technical committee on the Revision of Pipe Threads, and the following societies were asked to cooperate with this committee: American Gas Institute, American Society of Mechanical Engineers, Manufacturers' Association on Standardization of Fittings, Master Car Builders' Association, Railway Signal Association. Various forms of threads were proposed and a number of experiments were made by the committee to determine the strength of the threads, the tightness of the joint and the practicability of cutting the various forms of threads and of the interchangeability of the suggested types with the existing

standard. These experiments have been completed and results of the findings have been duly reported to the Society.[1]

This work, of course, is all preliminary, and the most difficult part of the work still lies before the committee. The tremendous manufacturing difficulties involved in any change in standard of pipe threads are fully realized. The type of pipe thread which may be employed is a matter of design, and while it is important to consider the design of thread in relation to the quality of material which is employed in the pipe, it would seem that this matter does not properly fall within the province of the American Society for Testing Materials, the purpose of which is "the promotion of knowledge of materials of engineering and the standardization of specifications and methods for testing," but that the work could more properly be conducted under the auspices of the American Society of Mechanical Engineers,—one of the cooperating societies,—the object of which society is to "promote the arts and sciences connected with engineering and mechanical construction."

In January, 1918, the Executive Committee approved the transfer of the future activities of Committee E-3 to the American Society of Mechanical Engineers, and the following resolutions were therefore submitted and unanimously adopted at a meeting of Committee E-3 held March 15:

> "*Whereas*, The Executive Committee of the American Society for Testing Materials has invited Committee E-3 on Revision of Pipe Threads to consider the desirability of its discontinuation under the auspices of the American Society for Testing Materials, with a view of effecting an arrangement for the continuation of the work under the auspices of the American Society of Mechanical Engineers; and
>
> "*Whereas*, The committee has completed its experimental work to determine the relation of the character and shape of pipe thread to the material employed; and
>
> "*Whereas*, A continuation of the work involves the establishment of purely mechanical standards; therefore,
>
> "*Be it resolved*, That the committee concur in the recommendation of the Executive Committee; and further,

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 504 (1917).

"*Be it resolved,* That it be recommended to the Executive Committee of the American Society for Testing Materials to invite the Council of the American Society of Mechanical Engineers to arrange for the continuation of the present committee and the completion of its work under the future auspices of that society instead of that of the American Society for Testing Materials."

This action of the committee was referred to the American Society of Mechanical Engineers and that society has accepted the responsibility for the continuance of the work, by the following letter under date of May 3, 1918, addressed by Mr. Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, to Mr. Edgar Marburg, Secretary-Treasurer of this Society:

May 3, 1918.

MR. EDGAR MARBURG,
Secretary-Treasurer, A.S.T.M.,

Dear Sir:

I have the honor to advise you that the Council of this Society has officially confirmed its agreeableness to arrange for the continuation of the present Committee E-3 on Revision of Pipe Threads and the completion of its work under the auspices of this society instead of that of the American Society for Testing Materials.

(Signed) CALVIN W. RICE.

The American Society of Mechanical Engineers has a committee on Pipe Threads International Standard, under the chairmanship of Mr. E. M. Herr, which has done a good deal of work in the past. Committee E-3 is now merged with this committee, and hereafter the work will be conducted under the auspices of the American Society of Mechanical Engineers.

This report has been submitted to Committee A-1 on Steel for its information.

It has also been submitted to letter ballot of the committee which consists of 17 members, of whom 11 have voted affirmatively, none negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

H. V. WILLE,
Chairman.

REPORT OF COMMITTEE E-4

ON

MAGNIFICATION SCALES FOR MICROGRAPHS.

Committee E-4 has held one meeting during the year, at which nine members were present and six absent.

The committee has considered the criticisms and suggestions received from various persons and organizations, including members of the Society, and offers the following amendments to the Tentative Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2–17 T), which were accepted at the last annual meeting and published as tentative.[1]

Section 1.—Add 1500 to the standard magnifications for general use.

Section 2 (*a*).—Add 1000 to the standard magnifications for making micrographs of steel and ferrous metals.

Section 3 (*a*).—Add 10, 50, and 100 to the standard magnifications for making micrographs of non-ferrous metals.

Section 3 (*b*).—Change from its present form to read as follows by the addition of the italicized words:

"(*b*) For general use in Society reports, and for showing grain size of copper and copper-*zinc* alloys, a magnification of 75 diameters shall be used.

"***For copper-nickel and copper-nickel-zinc alloys, a magnification of 150 diameters shall be used.***"

Add the following new paragraph (*c*):

"(*c*) For alloys of lead, tin and antimony, including those containing small percentages of copper, magnifications of 50 and 250 shall be used."

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XVII, Part I, p. 838 (1917).

Section 4 (*d*).—Add:

"With micrographs at magnifications of approximately 500 diameters and above, the numerical aperature of the objective and the type of illuminator shall be given."

Section 5 (*a*).—Change the parenthetical "*e. g.*, 20-mm. focal length" to read: "*e. g.*, approximately 35-mm. focal length."

Section 6.—Add the following new paragraph (*c*):

"(*c*) The magnification shall be determined by accurately measuring the image of a stage micrometer scale, and not by estimation from lens combinations, or microscope, or camera adjustments."

In the foot-note under Section 6 (*b*), change the word "entirely" in the last sentence to "mainly."

Section 8 (*a*).—Add as a note to this section, "Jeffries Method for Grain-Size Measurements[1]".

The amendments proposed are largely on account of the discussions received at the request of the Secretary-Treasurer from members, and from other societies in England and America. The fact that this discussion is apparently by no means complete, and that further discussion and criticism is anticipated, makes it seem to the committee inadvisable to ask that these Tentative Definitions and Rules be made standard at this time.

The committee therefore recommends that the Tentative Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys, as amended, remain tentative.

Several suggestions have been made that Etching Solutions and Methods of Etching should be standardized, but the committee does not believe this to be possible at present. In Section 4 (*d*) of the Definitions and Rules, it is required that a statement of the etching medium, treatment, etc., be printed in connection with each micrograph. The committee believes that this sufficiently covers the matter of etching.

The question of photographs at magnifications less than 10 diameters has been under discussion, but the committee

[1] The note referred to appears in the Tentative Definitions and Rules, pp. 716–721.—ED.

does not think it advisable to attempt to place in these Definitions and Rules any matter governing the magnification usually made by photographic lenses, or simple magnifiers which are taken without the use of the microscope.

This report has been submitted to letter ballot of the committee, which consits of 15 members, of whom 14 have voted affirmatively, none negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

W. H. BASSETT,
Chairman.

EDITORIAL NOTE.

The tentative definitions and rules referred to in this report were approved at the annual meeting in their proposed revised form and continued as tentative. They appear on pages 716–721.

REPORT OF COMMITTEE E-5

ON

STANDING COMMITTEES.

THIS COMMITTEE CONSISTS OF THE CHAIRMEN OF ALL STANDING COMMITTEES, OR REPRESENTATIVES DESIGNATED BY THE RESPECTIVE CHAIRMEN. THE DUTIES OF THIS COMMITTEE ARE THE FORMULATION OF (*a*) REGULATIONS GOVERNING STANDING COMMITTEES, (*b*) REGULATIONS GOVERNING THE FORM BUT NOT THE SUBSTANCE OF STANDARDS, AND (*c*) THE CLASSIFICATION OF STANDARDS.

Since the last annual meeting of the Society, Committee E-5 has held two meetings, one on December 15, 1917, and the other on March 9, 1918.

The activities of the committee during the year have been devoted mainly to its cooperation with the Executive Committee in the revision of the Regulations Governing Standing Committees, and in an advisory way concerning sundry other matters. The Regulations in their revised form appear in the Appendix to this report, in which the italicized parts represent new matter, and old matter, cancelled or superseded, is shown enclosed in brackets. For greater convenience of reference the regulations have been put in better typographic form by grouping them under eight divisions with distinctive self-explanatory titles, and by the use of numbered and titled side-headings for the various sections in each division. The paragraphs under a given section are distinguished by lower-case italics in parentheses.

This report has been submitted to letter ballot of the committee, which consists of 34 members, of whom 30 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

APPENDIX.

REGULATIONS GOVERNING STANDING COMMITTEES.

NOTE.—By action of the Executive Committee on January 6, 1912, the responsibility for the general Regulations Governing Standing Committees is vested in the Executive Committee and Committee E-5 on Standing Committees, with the understanding (1) that a proposed change in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5; and (3) that proposed changes in these Regulations thus adopted shall be announced in the next circular to members and become effective from the date of issue of that circular.

I. ORGANIZATION OF STANDING COMMITTEES.

1. Creation.—The creation of a standing committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

2. Appointments.—Appointments on standing committees shall be made by the Executive Committee subject to the following provisions:

(*a*) On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of producing and non-producing interests; or the latter may be allowed to predominate [with the acquiescence] *by majority vote* of the former.

(*b*) The classification of the members of a committee into producers and non-producers shall be left to each committee, subject to the following provisions, and with the understanding that a member dissatisfied with this classification has the right of appeal to the Executive Committee:

(1) A member who stands in the relation of producer to any product within the province of the committee shall be classed as a producer, although at the request of the officers of the committee concerned, attention shall be called to the status of such members in a footnote worded as follows:

These members of Committee............, classed as PRODUCERS, stand in the relation of PRODUCERS to certain products, and in that of NON-PRODUCERS to other products within the province of the committee.

(2) A nominally unattached expert, who is permanently retained by producing interests in the field of activities of the committee with which he is connected, shall be classed as a producer. The qualification "permanently retained" is to be understood to mean that the expert receives a regular monthly or yearly retainer from one or more producing interests under an indefinitely continuing arrangement.

(*c*) As a general policy, only one individual connected with a given firm, company, corporation, laboratory, or other institution shall be eligible to membership on a given committee, although exceptions to this rule may be permitted at the discretion of the committee concerned. In case two or more members of a committee are connected with the same firm, company, corporation, laboratory, or other institution, they shall, when a division is demanded, jointly command only a single vote.

(*d*) Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.

(*e*) Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

3. Preliminary Organization.—The President of the Society will appoint the chairman *pro tem.* of a new committee from the representatives of the non-producing interests. The chairman *pro tem.*, after communicating with the other members of the

committee, will fix the place and time of the first meeting. He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to economize time at the meeting and to afford a definite basis for discussion.

4. Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of non-producing interests, and such other officers and sub-committees as the committee may desire. The duties and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

II. DIRECTIONS FOR CONDUCT OF BUSINESS.

5. Meetings.—The meetings of standing committees and sub-committees shall be open only to their own members and to such visitors whose proposed invitation has been approved by the chairman.

6. Proxies.—A member of a standing committee shall be authorized to delegate any desired individual as his proxy with voting power, or without voting power, if so specified; but no individual shall have more than one vote at a meeting of a committee.

7. Election of Officers.—Every standing committee shall hold an election of officers at or before the annual meeting of the Society occurring in the even years. The term of office of every officer shall be two years and officers shall be eligible for re-election.

8. Resignations.—Proposed resignations from office or from membership on a standing committee shall be reported directly to the chairman or the secretary of the committee concerned, and the result of any action taken in such matters shall be reported to the Secretary-Treasurer of the Society.

9. Sub-Committees.—Sub-committees shall have no standing in the Society except through their parent committees. Sub-committees on proposed complete standard specifications for materials shall consist of not fewer than six members, and at least one-half of the membership shall be composed of non-producers. Departures from this requirement for exceptional reasons may be authorized by the Executive Committee.

III. REPORTS OF STANDING COMMITTEES.

10. Reports.—The reports of standing committees shall be presented at the annual meetings. The report of every sub-committee shall be made to the parent committee and not to the Society direct. If such a report is embodied wholly or in part in the report of the parent committee to the Society, the latter shall make definite references to such features in its own report and recommendations, if any, based thereon.

The report of a standing committee, before its presentation at the annual meeting, shall first have been submitted to letter ballot of the committee and shall have received the approval of the majority of those voting.

A statement of the following form shall appear at the close of every committee report:

This report has been submitted to letter ballot of the committee which consists of .... members, of whom .... have voted affirmatively, ... negatively, and ...... have refrained from voting.

Dissenting members shall have the right to present minority reports individually or jointly.

IV. STANDARDS AND RECOMMENDED PRACTICE.

11. Standards.—"The term 'Standards' shall be applied collectively to (*a*) standard specifications, (*b*) standard tests, (*c*) standard methods, and (*d*) standard definitions."[1]

(*a*) The term "Standard Specifications" shall be applied to specifications designed to govern the purchase of materials. Such specifications may or may not include reference to tests, but they shall include limits for physical, chemical or other properties.

(*b*) The term "Standard Tests" shall be applied to prescribed directions for tests of specific materials, but shall not include limits for physical, chemical or other properties.

(*c*) The term "Standard Methods" shall be applied to prescribed methods of procedure in the conduct of physical, chemical or other tests.

(*d*) The term "Standard Definitions" is self-explanatory.

12. Tentative Standards.—*The term "Tentative Standards" shall be applied to proposed standards which are published in the Proceedings for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action towards their adoption as "standard."*

[1] Quoted from by-laws, Art. VI, Sec. 1.

13. Recommended Practice.—"*The term 'Recommended Practice' shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer.*"[1]

14. Matters of Engineering Design.—In the preparation of proposed standards the consideration of matters of engineering design or construction shall not in general be regarded as falling within the province of the Society. If, however, it should appear to a given committee that the consideration of such matters is, for special reasons, indispensable in specifications designed to cover the customary relations between the producers and consumers of a given product, then reference to such matter in proposed specifications for that product shall be permitted within the scope necessary for the particular purpose above stated. Proposed standards embodying features of the character in question shall be submitted by the committee concerned to the Executive Committee for consideration and comment not later than the quarterly meeting immediately preceding the annual meeting at which the proposed standards are to be presented.

15. Preparation of Standards.—Proposed new standards or proposed amendments of existing standards shall originate in the particular committee within whose province such standards properly belong. No action affecting standards shall be taken by any standing committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. The results of each letter ballot as to the number of affirmative votes, the number of negative votes and the number of members not voting, shall be announced in the report of the committee to the Society. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

16. Advance Distribution of Standards.—[Any recommendations affecting standards] *The annual reports of the standing committees* shall be transmitted to the Secretary-Treasurer of the Society [at least] *as early in the calendar year as possible and not less than* eight weeks in advance of the date of the annual meeting. [and copies of these recommendations, in printed form,] *Preprints of these reports* shall be mailed by the Secretary-Treasurer to every member of the Society *at the earliest possible*

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[1] Quoted from by-laws, Art. VI, Sec. 1.

subsequent date and not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such [recommendations] *reports* and that members not intending to be present at the meeting may contribute discussions by letter.

17. Procedure Governing the Adoption of Standards.—Any recommendations affecting standards presented by the appropriate committees at the annual meeting of the Society shall be subject to the following provisions in Article VI, *Section 1*, of the by-laws:

[The term "Standards" shall be applied collectively to standard specifications, standard tests, standard methods, and standard definitions.]

"Proposed new standards [or proposed amendments of existing standards] shall be presented at [the] *an* annual meeting, *at which they may be amended* [At this meeting amendments may be made], by a two-thirds vote of those voting. [The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on] *On* two-thirds vote of those voting, *they shall be printed, as presented or as amended*, in the Proceedings [under a section designated], *and separately under the title* "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. [If introduced in an even year such tentative standards shall be published for two years, and if introduced in an odd year they shall be published for one year.] At the *next* annual meeting [in the next even year following their introduction, such] tentative standards shall be subject to amendment by a two-thirds vote of those voting. [and to reference] *They may then be referred*, by a like vote, to letter ballot of the Society, *in which case a* [A] two-thirds vote of those voting shall be required for adoption; *or, on the recommendation of the committee concerned, they may be continued as tentative, as printed or as amended, in which case the above prescribed procedures shall apply at any succeeding annual meeting.*

"*Proposed amendments of existing standards shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting. On two-thirds vote of those voting they shall be printed, as presented or as amended, in the Proceedings as part of the report of the appropriate committee; and collectively under the same cover with the Tentative Standards for that year. At any succeeding annual meeting they shall be subject to amendment by a two-thirds vote of those voting; and at the anual meeting*

in the year in which the book of A.S.T.M. Standards will next be published, they shall be subject to reference by a like vote to letter ballot of the Society, in which case a two-thirds vote of those voting shall be required for adoption.

"The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or [two] *more* years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected."

"[The term 'Recommended Practice' shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer.] The above requirements governing action on *proposed* new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice."

18. Standards Involving Patents.—"Reports, resolutions and recommendations pertaining to or involving the use, or proposed use, in a standard or tentative standard, of any device or process which forms the subject matter of any existing patent, shall first be submitted to the Executive Committee, and shall be submitted to the Society only with the approval of the Executive Committee."[1]

V. COOPERATION WITH COMMITTEES OF OTHER BODIES.

19. Methods of Initiating Cooperation.—[A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.] A standing committee desiring to *cooperate with committees of other bodies on like or cognate subjects, or to* bring about the appointment of similar committees by other [societies] *bodies* for purposes of cooperation, shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the desired end shall be conducted [on behalf of the Executive Committee] by the Secretary-Treasurer of the Society. *Such cooperative relations shall entail no conditions at variance with these regulations, and shall impose no restrictions upon the free and independent action of the standing committee.*

[1] Quoted from by-laws, Art. VI, Sec. 2.

20. Regulations Governing Cooperative Relations.

At the last annual meeting (1917) of the Society, a resolution was adopted:

> *"That the Executive Committee be requested to give consideration to the general subject of the formation of and methods of procedure to be followed by joint committees and the publication of joint reports; whether these joint committees be made up from various committees of this Society or of representatives of this Society and other societies and organizations."*

In pursuance of this resolution a sub-committee of the Executive Committee was appointed to report on this subject to the Executive Committee. This report was then referred to Committee E-5 on Standing Committees for consideration and advice. Committee E-5 approved the previous report to the Executive Committee on this subject, but recommended certain minor changes. Upon reconsideration, the Executive Committee concluded that it would be unwise to confirm their previous action by the adoption of the report of the original sub-committee with the proposed slight amendments recommended by Committee E-5.

The Executive Committee further concluded that action on Section 20 of the proposed revised "Regulations Governing Standing Committees" on Regulations Governing Cooperative Relations had better be deferred pending further developments in certain closely related matters, notably the completion of the proposed final report of the American Engineering Standards Organization Committee to the proposed five founder societies, including the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Electrical Engineers, and the American Society for Testing Materials, which is expected to become available prior to the annual meeting of this Society in June, 1918.

For the reasons stated, this section is temporarily left blank in anticipation of supplying its contents later.

VI. PUBLICATIONS.

21. Publications.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

VII. EXPENSES OF STANDING COMMITTEES.

22. Current Expenses.—Expenses for postage incurred in connection with the business of committees will be refunded by the Secretary-Treasurer of the Society on vouchers approved by the chairman of these committees.

23. Stationery.—Correspondence relating to the business of committees or sub-committees shall be conducted on official stationery which will be furnished by the Secretary-Treasurer of the Society.

24. Extraordinary Expenses.—Expenses for items other than postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of previous authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

25. Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus collected shall be transmitted to the Secretary-Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

26. Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Secretary-Treasurer of the Society. Payments for such purposes shall be made by the Secretary-Treasurer of the Society only on vouchers approved by the chairman of the committee concerned.

VIII. DISCHARGE OF STANDING COMMITTEES.

27. Discharge of Standing Committees.—Standing committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed, or in consequence of protracted inactivity. A standing committee which fails to present a report at three successive annual meetings of the Society will be required to show cause, in a written communication to the Executive Committee, why it should not be discharged.

Standing committees may be discharged for cause by the Executive Committee at its own initiative.

AMERICAN REPRESENTATION ON COMMITTEES OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Nominations.—In making nominations for appointment of American members on International committees on a subject, falling within the province of an American standing committee, the sense of the latter committee as to the selection of the nominee shall be obtained before final action on the part of the Executive Committee.

Relation between American Representatives on International Committees and American Committees on the same Subjects.—The American representative or representatives on an International committee dealing with subjects falling within the province of an American standing committee shall keep that committee fully advised as to the important developments in the work of the International committee. Formal recommendations to the International committee on the part of such representative or representatives, and their vote on letter ballot of that committee, shall be subject to advance approval on the part of the American committee.

RECOMMENDATIONS TO STANDING COMMITTEES.

The following recommendations to standing committees have been approved by the Executive Committee and Committee E-5:

It is recommended that the various standing committees should formulate proposed standard definitions of terms in matters falling in their respective fields, and that in the case of terms which come within the province of two or more com-

mittees, such definitions be formulated by joint action, through sub-committees, on the part of the committees concerned. Such proposed standard definitions of terms will be subject to adoption by the Society under the provisions of the by-laws and the Regulations Governing Standing Committees.

An alphabetic glossary of standard definitions of terms will be published in the Book of A.S.T.M. Standards as soon as their number appears to warrant such action.

COOPERATIVE POSSIBILITIES BETWEEN U. S. GOVERNMENT LABORATORIES AND A.S.T.M. STANDING COMMITTEES.

The basis on which various government branches may cooperate with the committees of this Society are indicated in the 1916 book of A.S.T.M. Standards, and in the 1917 Membership Pamphlet. Any committee desiring to establish such cooperative relations shall address a recommendation to that effect to the Executive Committee, and on approval of the latter, negotiations to the desired end shall be conducted by the Secretary-Treasurer of the Society.

REPORT OF COMMITTEE E-6

ON

PAPERS AND PUBLICATIONS.

Since the last annual meeting there has been no occasion to hold a general meeting of Committee E-6. Its functions relative to the acceptance of papers have been discharged by the Advisory Committee and other members of the committee who have given individual expert advice. The committee has also received assistance of this kind from members of the Society not connected with the committee, for which it desires to record its appreciative acknowledgment.

The program this year, while not the largest in the history of the Society, is believed to be one of the most important and interesting in recent years. Topical Discussions will be held on two subjects, namely, "Cooperation in Industrial Research," to which an entire session has been devoted, and "Season and Corrosion Cracking of Brass," while the presentation of a paper and discussions on "Cast Steel Anchor Chain" is of timely interest. Arrangements have been made for a joint session with the American Concrete Institute, devoted to Cement and Concrete. An interesting and instructive motion picture showing motion photomicrographs of fatigue failure of wrought iron will also be presented.

The program contains 28 committee reports and 20 papers, exclusive of the two Topical Discussions, each of which will be formally introduced by the presentation of five papers. The Advisory Committee has had to decline several offers of papers received after the expiration of the limiting date announced in a circular to members. It has also had to decline, for various reasons, certain offers received at an earlier date, as well as several papers which had been provisionally accepted by title. The material in view for this meeting aggregates 870 pages, as compared with 1078 pages for last year.

In its report last year, Committee E-6 recommended that the Executive Committee take steps looking towards the earlier submission of both committee reports and papers, especially reports containing recommendations as to standards or tentative standards. The Regulations Governing Standing Committees have accordingly been revised to provide that annual reports of all standing committees shall be transmitted to the Secretary-Treasurer "as early in the calendar year as possible, and not later than eight weeks in advance of the annual meeting." Preprints of these reports shall be mailed by the Secretary-Treasurer to every member of the Society "at the earliest

TABLE I.—ANALYSIS OF PREPRINTING.

Instalment No.	Date of Mailing.	Committee Reports.						Papers and Discussions.		Total.	
		Affecting Standards.		Not Affecting Standards.		Total.					
		No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.
1	April 29	12	98	1	4	13	102	1	10	14	112
2	May 31	9	180	1	12	10	192	10[a]	150	20[a]	342
3	June 17	..	..	5[b]	65	5[b]	65	8	171	13[b]	236
4	Not mailed, printed for Annual Meeting only	..	..	4[b]	95	4[b]	94	7[c]	86	11[b, c]	180
Totals						32[b]	453	26[a, c]	417	58[a,b,c]	870

[a] Includes the two Topical Discussions.
[b] Includes two preprints which supplement two reports in earlier instalments.
[c] Includes five contributions to Topical Discussions.

possible subsequent date, and not less than four weeks before the annual meeting."

In November, 1917, the Secretary-Treasurer circularized the officers of the standing committees and urged, first, that their final meetings prior to this annual meeting be held as early in 1918 as possible, and second, that manuscripts of their annual reports be submitted as early in the year as possible and preferably before March 1. In view of the pressure under which the members of the standing committees are working owing to the present state of war, the results have on the whole been very encouraging. The first instalment of preprints was mailed at the end of April, a month earlier than usual, and the

second instalment was mailed at the end of May. All committee reports containing recommendations as to standards were included in these two instalments, and were thus distributed the prescribed four weeks in advance of the annual meeting. The third and final instalment was mailed June 17.

An analysis of the preprinting for this annual meeting appears in Table I. All committee reports and papers on the program, with the exception of one paper, will be available at the meeting in printed form. Of these all but two reports and two papers have been distributed in advance to the members of the Society. In addition to the items on the program, certain contributions to the Topical Discussions and three specifications submitted by one of the committees too late to admit of printing for advance distribution, aggregating approximately 50 pages, have also been printed for use at the meeting.

TABLE II.—COMPARATIVE DATA FOR PREPRINTS.

Year.	Preprints.			On Program, but not Preprinted, pages.
	Distributed in Advance, pages.	Not Distributed in Advance, pages.	Total, pages.	
1913	461	238	699	81
1914	668	260	928	11
1915	891	76	967	0
1916	846	91	937	0
1917	978	100	1078	0
1918	690	180	870	15 (estimated)

The comparative data for preprints since 1913, when preprinting was first undertaken on an extensive scale, are given in Table II.

This report has been submitted to letter ballot of the committee, which consists of nine members, of whom 7 have voted affirmatively, none negatively and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

A.S.T.M.
TENTATIVE STANDARDS

CONSISTING OF

TENTATIVE SPECIFICATIONS, TENTATIVE TESTS, TENTATIVE METHODS, TENTATIVE DEFINITIONS AND TENTATIVE RECOMMENDED PRACTICE.

The term Tentative Standards is applied to proposed Standards which are printed for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action towards their adoption as standard.

Members of the Society and others are invited to direct written criticism of any of these Tentative Standards to the officer of the appropriate committee whose name and address appear in the footnote to the title of each Tentative Standard.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS

FOR

STEEL TIE PLATES.

Serial Designation: A 67 – 18 T.[1]

These specifications are issued under the fixed designation A 67; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916; REVISED, 1917, 1918.

In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society.

Material Covered. 1. These specifications cover two grades of steel tie plates, namely: soft and medium. The soft grade will be used unless otherwise specified.

I. MANUFACTURE.

Process. 2. The steel may be made by the Bessemer or open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

Bessemer.	Soft Grade.	Medium Grade.
Carbon, per cent..........	not under 0.06	not under 0.12
Phosphorus, per cent......	not over 0.10	not over 0.10
Open-Hearth.		
Carbon, per cent..........	not under 0.12	not under 0.20
Phosphorus, per cent......	not over 0.06	not over 0.06

Ladle Analyses. 4. (*a*) A carbon determination shall be made of each melt of Bessemer steel, and two analyses every 24 hours representing the average of the elements carbon, manganese, phosphorus and sulfur, contained in the steel, one for each day and night turn respectively. These analyses shall be made from drillings taken at least $\frac{1}{8}$ in. beneath the surface of a test ingot obtained during the pouring of the melts. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

(*b*) An analysis of each melt of open-hearth steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulfur. This analysis shall be made from drillings taken at least $\frac{1}{8}$ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analyses. 5. An analysis may be made by the purchaser from a finished tie plate representing each melt of open-hearth steel, and each melt or lot of 10 tons of Bessemer steel. The carbon content thus determined shall not be less than that specified in Section 3, and the phosphorus content shall not exceed that specified in Section 3 by more than 25 per cent.

III. PHYSICAL PROPERTIES AND TESTS.

Bend Tests. 6. The bend test specimens specified in Section 7 shall bend cold through 180 deg. around a pin the diameter of which is equal to the thickness of the specimen for the soft grade, and to twice the thickness of the specimen for the medium grade, without cracking on the outside of the bent portion.

Test Specimens. 7. Bend test specimens shall be taken from the finished tie plates, or from the rolled bars; and longitudinally with the

rolling. They shall be rectangular in section, not less than ½ in. in width between the planed sides, and shall have two parallel faces as rolled. They shall be free from ribs or projections. Where the design of the tie plates is such that the specimen cannot be taken between the ribs or projections, these ribs or projections shall, in preparing the specimen, be planed off even with the main surface of the tie plate.

Optional Bend Tests.

8. If preferred by the manufacturer and approved by the purchaser, the following bend test may be substituted for that described in Section 6:

A piece of the rolled bar shall bend cold through 90 deg. around a pin the diameter of which is equal to the thickness of the section where bent for the soft grade, and to twice the thickness of the section where bent for the medium grade, without cracking on the outside of the bent portion.

Number of Tests.

9. (*a*) One bend test shall be made from each melt of open-hearth steel, or from each melt or lot of 10 tons of Bessemer steel.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

IV. WORKMANSHIP AND FINISH.

Workmanship.

10. The tie plates shall be smoothly rolled, true to templet, and shall be straight and out of wind on the surface which will form the bearing for the rail. They shall conform to the dimensions specified by the purchaser, with the following permissible variations:

(*a*) For plates with shoulders parallel to the direction of rolling, a variation of $\frac{1}{32}$ in. in thickness, $\frac{1}{8}$ in. in rolled width, and $\frac{3}{16}$ in. in sheared length will be permitted.

(*b*) For plates with shoulders perpendicular to the direction of rolling, a variation of $\frac{1}{32}$ in. in thickness, $\frac{1}{8}$ in. in rolled width, and $\frac{1}{4}$ in. in sheared length will be permitted. The distance from the face of shoulder to the outside end of plate shall not vary more than $\frac{1}{4}$ in., and from the face of shoulder to the inside end not more than $\frac{1}{8}$ in.

Finish.

11. The finished tie plates shall be free from burrs and other surface deformations caused by the shearing and punching;

they shall also be free from other injurious defects and shall have a workmanlike finish.

V. MARKING.

Marking. 12. The name or brand of the manufacturer, the section and the year of manufacture shall be rolled in raised letters and figures on the outside of the shoulder of the plates, and a portion of this marking shall appear on each finished tie plate.

VI. INSPECTION AND REJECTION.

Inspection. 13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the tie plates ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tie plates are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 14. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported within five working days from the receipt of samples.

(*b*) Tie plates which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing. 15. Samples tested in accordance with Section 5, which represent rejected tie plates, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR BOILER AND FIREBOX STEEL FOR STATIONARY SERVICE.[1]

Serial Designation: A 70 – 18 T.

These specifications are issued under the fixed designation A 70; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916; REVISED, 1917, 1918.

In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulfur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society.

Material Covered.

1. These specifications cover two grades of steel for boilers for stationary service, namely: flange and firebox.

I. MANUFACTURE.

Process.

2. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

3. The steel shall conform to the following requirements as to chemical composition:

		FLANGE.	FIREBOX.	
Carbon	For plates ¾ in. or under in thickness.........	.....	0.12 – 0.25	per cent
	For plates over ¾ in. in thickness...........	.....	0.12 – 0.30	"
Manganese	....	0.30 – 0.60	0.30 – 0.60	"
Phosphorus	Acid.............	not over 0.05	not over 0.04	"
	Basic............	" " 0.04	" " 0.035	"
Sulfur	....	" " 0.05	" " 0.04	"

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

Ladle Analyses. 4. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 3. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analyses. 5. An analysis may be made by the purchaser from a broken tension test specimen representing each plate as rolled. The chemical composition thus determined shall conform to the requirements specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 6. (*a*) The material shall conform to the following requirements as to tensile properties:

	FLANGE AND FIREBOX.
Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent	$\frac{1\ 500\ 000}{\text{Tens. str.}}$;

but for firebox steel not less than 24 per cent, subject to the modifications of Section 7.

(*b*) The yield point shall be determined by the drop of the beam of the testing-machine.

Modifications in Elongation. 7. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 0.5 from the percentages of elongation specified in Section 6 (*a*) shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., to a minimum of 20 per cent.

(*b*) For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

Bend Tests. 8. The test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

Homogeneity Tests. 9. For firebox steel, a sample taken from a broken tension test specimen shall not show any single seam or cavity more than $\frac{1}{4}$ in. long, in either of the three fractures obtained in the test for homogeneity, which shall be made as follows:

The specimen shall be either nicked with a chisel or grooved on a machine, transversely, about $\frac{1}{16}$ in. deep, in three places about 2 in. apart. The first groove shall be made 2 in. from the square end; each succeeding groove shall be made on the opposite side from the preceding one. The specimen shall then be firmly held in a vise, with the first groove about $\frac{1}{4}$ in. above the jaws, and the projecting end broken off by light blows of a hammer, the bending being away from the groove. The specimen shall be broken at the other two grooves in the same manner. The object of this test is to open and render visible to the eye any seams due to failure to weld up or to interposed foreign matter, or any cavities due to gas bubbles in the ingot. One side of

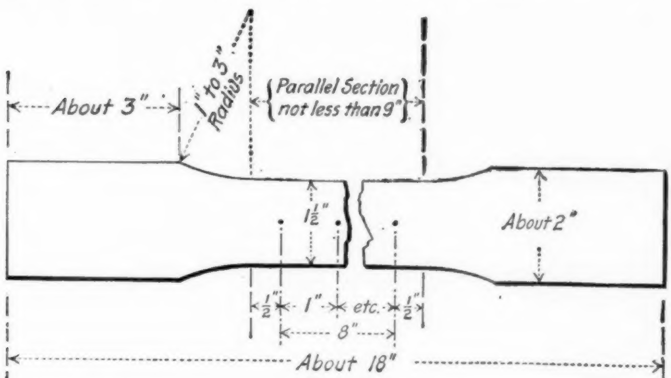

FIG. 1.

each fracture shall be examined and the lengths of the seams and cavities determined, a pocket lens being used if necessary.

10. (*a*) Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimen at right angles to that axis. **Test Specimens.**

(*b*) Tension and bend test specimens shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

11. (*a*) One tension and one bend test shall be made from each plate as rolled. **Number of Tests.**

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6 (*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS.

Permissible Variations.

12. The thickness of each plate shall not vary more than 0.01 in. under that ordered.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS.

Ordered Thickness, in.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Nominal Weights.									Ordered Thickness, in.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over.	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	..	1/8 to 3/16 excl.
3/16 " 1/4 "	7	8	9	10	12	..	..	..	..	3/16 " 1/4 "
1/4 " 5/16 "	6	7	8	9	10	12	14	16	19	1/4 " 5/16 "
5/16 " 3/8 "	5	6	7	8	9	10	12	14	17	5/16 " 3/8
3/8 " 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 " 7/16 "
7/16 " 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 " 1/2 "
1/2 " 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 " 5/8 "
5/8 " 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 " 3/4 "
3/4 " 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 " 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

The overweight of each lot[1] in each shipment shall not exceed the amount given in Table I. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

V. FINISH.

Finish.

13. The finished material shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING.

Marking.

14. (*a*) The name or brand of the manufacturer, melt or slab number, grade, and lowest tensile strength for its grade

[1] The term "lot" applied to Table I means all of the plates of each group width and group thickness.

specified in Section 6 (*a*), shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen.

(*b*) When specified on the order, plates shall be match-marked as defined in Paragraph (*c*) so that the test specimens representing them may be identified. When more than one plate is sheared from a single slab or ingot, each shall be match-marked so that they may all be identified with the test specimens representing them.

(*c*) Each match mark shall consist of two over-lapping circles each not less than $1\frac{1}{2}$ in. in diameter, placed upon the shear lines, and made by separate impressions of a single-circle steel die.

(*d*) Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted.

VII. INSPECTION AND REJECTION.

15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

16. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5, shall be reported within five working days from the receipt of samples. **Rejection.**

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

17. Samples tested in accordance with Section 5, which represent rejected material, shall be preserved for two weeks from date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
CARBON TOOL STEEL.[1]

Serial Designation: A 71 – 17 T.

These specifications are issued under the fixed designation A 71; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulfur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society.

Material Covered. 1. These specifications cover carbon tool steel in ten classes and three grades, determined by the chemical composition specified in Section 3.

I. MANUFACTURE.

Process. 2. The steel shall be made by the crucible or electric process, with the exception of Grade C, which may be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition 3. The steel shall conform to the following requirements as to chemical composition:

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

Elements Considered.	Class No.	Grade A.	Grade B.	Grade C.
Carbon, per cent	1	0.45 - 0.60	(Same as Grade A)	(Same as Grade A)
	2	0.60 - 0.75		
	3	0.75 - 0.90		
	4	0.90 - 1.05		
	5	1.05 - 1.20		
	6	1.20 - 1.35		
	7	1.35 - 1.50		
	8	1.50 - 1.65		
	9	1.65 - 1.80		
	10	1.80 - 1.95		
Manganese, max., per cent		0.40	0.45	0.60
Phosphorus, max., per cent		0.02	0.025	0.035
Sulfur, max., per cent		0.02	0.035	0.04
Silicon, max., per cent		0.35	0.35	0.25

Chemical Analyses. 4. In case of dispute, the chemical analyses shall be made in accordance with the Standard Methods for Chemical Analysis of Plain Carbon Steel (Serial Designation: A 33)[1] of the American Society for Testing Materials.

III. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Permissible Variations. 5. The permissible variations in the size of the material ordered shall be agreed upon by the contractor and the purchaser.

IV. FINISH.

Finish. 6. The material shall be free from injurious defects, and shall have a workmanlike finish.

V. MARKING.

Marking. 7. The identification marks to be placed on the material shall be agreed upon by the contractor and the purchaser.

VI. INSPECTION AND REJECTION.

Inspection. 8. The contractor shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

Rejection 9. Material which does not conform to the chemical composition and agreed variations, or which shows injurious defects, will be rejected, and the contractor shall be notified.

[1] 1918 Book of A.S.T.M. Standards.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR LOW-CARBON-STEEL TRACK BOLTS.[1]

Serial Designation: A 76 – 18 T.

These specifications are issued under the fixed designation A 76; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the Society.

I. MANUFACTURE.

Process. 1. (*a*) The steel may be made by the Bessemer or open-hearth process.

(*b*) The threads may be cut or rolled.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 2. (*a*) The steel for the bolts shall conform to the following requirements as to chemical composition:

Phosphorus	Bessemer	not over 0.10 per cent.
	Open-hearth	" " 0.05 "

(*b*) The steel for the nuts shall be "soft steel."

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

3. (*a*) A carbon determination shall be made of each melt of Bessemer steel, and two analyses every 24 hours representing the average of the elements carbon, manganese, phosphorus and sulfur, contained in the steel, one for each day and night turn respectively. These analyses shall be made from drillings taken at least $\frac{1}{8}$ in. beneath the surface of a test ingot obtained during the pouring of the melts. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 2. **Ladle Analyses.**

(*b*) An analysis of each melt of open-hearth steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulfur. This analysis shall be made from drillings taken at least $\frac{1}{8}$ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 2.

4. An analysis may be made by the purchaser from a finished bolt representing each melt. The phosphorus content thus determined shall not exceed that specified in Section 2 by more than 25 per cent. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

5. The stock from which the bolts are made shall conform to the following requirements as to tensile properties: **Tension Tests.**

Tensile strength, lb. per sq. in	55 000 - 70 000
Elongation in 8 in., min., per cent...........	$\frac{1\,500\,000}{\text{Tens. str.}}$

6. The test specimen shall bend cold through 180 deg. flat on itself without cracking on the outside of the bent portion. **Bend Tests.**

7. Tension and bend test specimens shall be taken from the full-size rolled bars. Tension test specimens shall be of 8-in. gage length. **Test Specimens.**

8. (*a*) One tension and one bend test shall be made from each melt of steel. When the melts can not be identified, one tension and one bend test shall be made from each lot of 10 tons or fraction thereof. **Number of Tests.**

(*b*) If any test specimen develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5 and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests. 9. If the results of the physical tests of any test lot do not conform to the requirements specified, two additional tension and two additional bend tests shall be made from such lot, all of which shall conform to the requirements specified.

IV. WORKMANSHIP AND FINISH.

Workmanship. 10. The bolts and nuts shall conform to the dimensions specified by the purchaser. They shall be neatly formed, free from fins or nickings. The head shall be concentric with, and firmly joined to, the body of the bolt, with the underside of the head at right angles to the body of the bolt. The threads shall be sharp and true to gage and of the pattern specified by the purchaser. The nuts shall fit the bolts hand free, two to six turns, and wrench tight the balance of the way without distorting the threads or twisting the bolts. The nuts shall be screwed on before shipping, a sufficient number of turns to hold them on to destination. A variation of $\frac{1}{32}$ in. under and $\frac{1}{64}$ in. over the specified diameter of the body of the bolt will be permitted. The diameter of the rolled threads shall not exceed the diameter of the body of the bolt more than $\frac{1}{16}$ in. for $\frac{7}{8}$-in. bolts and $\frac{3}{32}$ in. for 1-in. bolts. The length of the bolt under the head shall not vary more than $\frac{1}{8}$ in. from that specified. A variation in the dimensions of the elliptical shoulders under the head of the bolt of $\frac{1}{32}$ in. from the specified size will be permitted. A taper of the shoulder of $\frac{1}{32}$ in. will be permitted.

Finish. 11. The finished bolts and nuts shall be free from injurious defects and shall have a workmanlike finish.

V. MARKING.

Marking. 12. (*a*) A letter or brand indicating the manufacturer shall be pressed on the head of the bolt when it is formed.

(*b*) Bolts shall be packed in serviceable packages. All packages shall be plainly marked as to material, size of bolts and name of manufacturer.

VI. INSPECTION AND REJECTION.

13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the bolts and nuts ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the bolts and nuts are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

14. Bolts and nuts which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified. **Rejection.**

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TENTATIVE SPECIFICATIONS
FOR
ELECTRIC CAST STEEL ANCHOR CHAIN.[1]

Serial Designation: A 77 – 18 T.

These specifications are issued under the fixed designation A 77; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover the cast steel to be used in all parts of the complete chain, including stud links, enlarged links, end links, shackles and shackle pins for anchor chain $1\frac{3}{8}$ in. and over.

I. MANUFACTURE.

Process. 2. (*a*) The steel shall be made by the electric furnace process, and all castings shall be produced in dry sand molds or cores.

(*b*) Each complete shot of chain shall be heat-treated in such manner that the treatment will be complete and uniform throughout its entire length.

Weight. 3. The weight of each shot of chain shall not be less than the minimum weight specified in Table I.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

II. PHYSICAL TESTS.

Test Chains.

4. (*a*) For each complete shot of 15 fathoms obtained there shall be cast two test chains consisting of at least one link from each heat entering into the production of that shot of chain. Each link in the test chains shall be properly marked for identification with the heat from which it is poured. The test chains shall contain not less than three links.

(*b*) Such test chains shall become the basis, as provided in Section 5, for the acceptance or rejection of the material entering into the shot of chain they represent.

TABLE I.—MINIMUM WEIGHT PER SHOT OF 15 FATHOMS.

Size of Chain, in.	Weight, lb.	Size of Chain, in.	Weight, lb.	Size of Chain, in.	Weight, lb.
$1\frac{3}{8}$	1 625	$2\frac{1}{8}$	3 785	$2\frac{7}{8}$	7 015
$1\frac{7}{16}$	1 775	$2\frac{3}{16}$	4 015	$2\frac{15}{16}$	7 330
$1\frac{1}{2}$	1 935	$2\frac{1}{4}$	4 245	3	7 650
$1\frac{9}{16}$	2 090	$2\frac{5}{16}$	4 485	$3\frac{1}{16}$	7 980
$1\frac{5}{8}$	2 235	$2\frac{3}{8}$	4 725	$3\frac{1}{8}$	8 320
$1\frac{11}{16}$	2 410	$2\frac{7}{16}$	4 960	$3\frac{3}{16}$	8 660
$1\frac{3}{4}$	2 590	$2\frac{1}{2}$	5 265	$3\frac{1}{4}$	9 010
$1\frac{13}{16}$	2 785	$2\frac{9}{16}$	5 535	$3\frac{5}{16}$	9 360
$1\frac{7}{8}$	2 975	$2\frac{5}{8}$	5 815	$3\frac{3}{8}$	9 725
$1\frac{15}{16}$	3 175	$2\frac{11}{16}$	6 105	$3\frac{7}{16}$	10 095
2	3 355	$2\frac{3}{4}$	6 405	$3\frac{1}{2}$	10 475
$2\frac{1}{16}$	3 570	$2\frac{13}{16}$	6 705	$3\frac{3}{4}$	12 025

(*c*) Both test chains shall be heat-treated with the complete shot of chain which they represent.

Breaking Tests.

5. (*a*) One of the test chains shall be pulled in an approved static testing machine to a breaking load in accordance with the loads specified in Table II. If this first test chain withstands the required tensile breaking load, the shot of chain which it represents shall be accepted so far as this test is concerned.

(*b*) If any link in the first test chain fails to withstand the required tensile breaking load, the second test chain shall be subjected to the same test. Prior to this retest the shot of chain and the second test chain may be subjected to a re-heat

treatment at the option of the manufacturer. If the second test chain passes the required test the shot of chain which it represents shall be accepted so far as this test is concerned. If the second test chain fails to pass the required test the shot of chain shall be rejected.

Proof Tests. 6. (*a*) The complete shot of chain shall then be subjected to a proof test, which shall consist of anchoring each end thereof in an approved static testing machine and subjecting it to the proof load shown in Table II, according to its respective size. If the shot of chain passes this test it shall be accepted.

TABLE II.—PROOF AND BREAKING LOADS.

Size of Chain, in.	Proof Test, lb.	Breaking Test, lb.	Size of Chain, in.	Proof Test, lb.	Breaking Test, lb.	Size of Chain, in.	Proof Test, lb.	Breaking Test, lb.
$1\frac{3}{8}$	114 000	160 000	$2\frac{1}{8}$	255 000	357 000	$2\frac{7}{8}$	431 500	604 000
$1\frac{7}{16}$	124 500	175 000	$2\frac{3}{16}$	270 000	378 000	$2\frac{15}{16}$	444 500	622 000
$1\frac{1}{2}$	131 500	184 000	$2\frac{1}{4}$	285 000	400 000	3	457 000	640 000
$1\frac{9}{16}$	137 500	193 000	$2\frac{5}{16}$	302 000	423 000	$3\frac{1}{16}$	469 500	658 000
$1\frac{5}{8}$	149 000	208 000	$2\frac{3}{8}$	318 500	446 000	$3\frac{1}{8}$	482 000	676 000
$1\frac{11}{16}$	160 500	225 000	$2\frac{7}{16}$	335 000	470 000	$3\frac{3}{16}$	494 500	693 000
$1\frac{3}{4}$	173 000	242 000	$2\frac{1}{2}$	353 000	494 000	$3\frac{1}{4}$	506 500	710 000
$1\frac{13}{16}$	185 500	260 000	$2\frac{9}{16}$	366 000	512 000	$3\frac{5}{16}$	518 500	726 000
$1\frac{7}{8}$	198 000	278 000	$2\frac{5}{8}$	379 000	531 000	$3\frac{3}{8}$	530 500	742 000
$1\frac{15}{16}$	211 500	296 000	$2\frac{11}{16}$	392 500	550 000	$3\frac{7}{16}$	541 500	758 000
2	226 000	316 000	$2\frac{3}{4}$	405 500	568 000	$3\frac{1}{2}$	553 000	775 000
$2\frac{1}{16}$	240 000	336 000	$2\frac{13}{16}$	418 500	586 000	$3\frac{3}{4}$	588 500	824 000

(*b*) If any link or links, not exceeding three in any one shot of 15 fathoms, fail during the proof test a new link or links may be cast in and the shot re-treated and again subjected to the proof tests. If it passes this retest the shot shall be accepted, provided the new link or links are poured from a heat represented in a test chain which had passed its prescribed breaking tests. If it does not pass this retest the shot shall be rejected.

(*c*) If more than three links of any one shot of 15 fathoms fail on proof test, the shot shall be rejected.

Shock Tests. 7. In addition to the breaking and proof tests specified in Sections 5 and 6, the material entering into the manufacture of

the chain shall be subjected to such shock tests as shall be agreed upon between the manufacturer and the purchaser, in order to determine its shock-resisting qualities.

8. In the event that only one test chain is subjected to test, the remaining test chain may be united with and become a part of another complete shot of chain, and shall be considered acceptable although not represented by any link in the test chains for the new shot. **Use of Second Test Chain.**

III. DIMENSIONS AND PERMISSIBLE VARIATIONS.

9. All castings shall conform to the dimensions and permissible variations agreed upon between the manufacturer and the purchaser. **Dimensions.**

IV. FINISH.

10. All castings shall be free from shrinkage, porosity or other injurious defects which would affect the strength of the chain, and shall have a workmanlike finish. **Finish.**

V. MARKING.

11. Each shot of chain accepted shall be legibly stenciled in accordance with the requirements of the purchaser. **Marking.**

VI. INSPECTION.

12. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the chain ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the chain is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
MALLEABLE CASTINGS.[1]

Serial Designation: A 75 – 18 T.

These specifications are issued under the fixed designation A 75; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

Material Covered. 1. These specifications cover malleable castings for railroad, motor vehicle, agricultural implement, and general machinery purposes.

I. MANUFACTURE.

Process. 2. The castings shall be produced by either the air-furnace, open-hearth, or electric-furnace process.

II. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 3. The tension test specimens specified in Section 5 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	45 000
Elongation in 2 in., per cent	7.5

Special Tests. 4. (*a*) All castings, if of sufficient size, shall have cast thereon test lugs of a size proportional to the thickness of the

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. H. E. Diller, Chairman of Committee A-7 on Malleable Castings, General Electric Co., Erie, Pa.

casting, but not exceeding $\frac{5}{8}$ by $\frac{3}{4}$ in. in cross-section. On castings which are 24 in. or over in length, a test lug shall be cast near each end. These test lugs shall be attached to the casting at such a point that they will not interfere with the assembling of the castings, and may be broken off by the inspector.

(*b*) If the purchaser or his representative so desires, a casting may be tested to destruction. Such a casting shall show good, tough malleable iron.

Tension Test Specimens.

5. (*a*) Tension test specimens shall be of the form and dimensions shown in Fig. 1. Specimens whose mean diameter at the smallest section is less than $\frac{19}{32}$ in. will not be accepted for test.

(*b*) A set of three tension test specimens shall be cast from each melt, without chills, using heavy risers of sufficient height

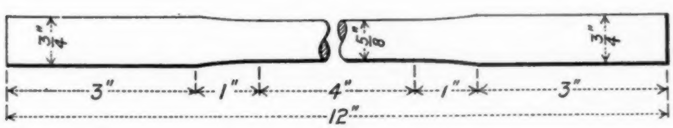

FIG. 1.

to secure sound bars. The specimens shall be suitably marked for identification with the melt. Each set of specimens so cast shall be placed in some one oven containing castings to be annealed.

Number of Tests.

6. (*a*) After annealing, three tension test specimens shall be selected by the inspector as representing the castings in the oven from which these specimens are taken.

(*b*) If the first specimen conforms to the specified requirements, or if, in the event of failure of the first specimen, the second and third specimens conform to the requirements, the castings in that oven shall be accepted, except that any casting may be rejected if its test lug shows that it has not been properly annealed. If either the second or third specimen fails to conform to the requirements, the entire contents of that oven shall be rejected.

Re-annealing.

7. Any castings rejected for insufficient annealing may be re-annealed once. The re-annealed castings shall be inspected

and if the remaining test lugs, or castings broken as specimens, show the castings to be thoroughly annealed, they shall be accepted; if not, they shall be finally rejected.

III. WORKMANSHIP AND FINISH.

Workmanship. 8. The castings shall conform substantially to the patterns or drawings furnished by the purchaser, and also to gages which may be specified in individual cases. The castings shall be made in a workmanlike manner. A variation of $\frac{1}{8}$ in. per ft. will be permitted.

Finish. 9. The castings shall be free from injurious defects.

IV. MARKING.

Marking. 10. The manufacturer's identification mark and the pattern numbers assigned by the purchaser shall be cast on all castings of sufficient size, in such positions that they will not interfere with the service of the castings.

V. INSPECTION AND REJECTION.

Inspection. 11. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The manufacturer shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test specimens cast from such melts. These records shall be available and shown to the inspector whenever required.

Rejection. 12. Castings which show injurious defects subsequent to their acceptance at the manufacturer's works may be rejected, and, if rejected, shall be replaced by the manufacturer free of cost to the purchaser.

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TENTATIVE SPECIFICATIONS
FOR
NON-FERROUS ALLOYS FOR RAILWAY EQUIPMENT IN INGOTS, CASTINGS, AND FINISHED CAR AND TENDER BEARINGS.[1]

Serial Designation: B 17 – 18 T.

These specifications are issued under the fixed designation B 17; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

Material Covered.

1. (*a*) These specifications cover the various non-ferrous alloys for locomotive equipment in ingots, castings and finished car and tender bearings.

(*b*) These alloys and the purposes for which they are used are as follows:

Bearing Metal No. 1, for connecting-rod bearings, bushings, eccentric straps, crosshead gibs and miscellaneous bushings;

Bearing Metal No. 2, for driving-box bearings, engine-truck and trailer bearings, and hub liners;

Bearing Metal No. 3, for lead-lined bearings, for locomotive tenders, freight and passenger-car equipment;

Bell Metal, for locomotive bells only;

Babbitt Metal, for babbitting driving boxes, rod brasses, crossheads, and for hub liners;

Lining Metal, for lining truck brasses, tender brasses and car brasses.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

I. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 2. (*a*) The alloys shall conform to the following requirements as to chemical composition, with the permissible variations specified:

Alloy.	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, max., per cent.	Iron max., per cent.	Antimony, per cent.	Phosphorus, max., per cent.	Sulfur max, per cent.	Arsenic, max., per cent.	Total Impurities, including Zinc, max., per cent.
Bearing Metal No. 1........	remainder	9–11	9–11	0.75	0.25	0.25*a*	1.0*b*	....	....	1.0
Bearing Metal No. 2.......	remainder	4–6	22.5-26.5	0.75	0.40	0.50*a*	....	....	....	1.5
Bearing Metal No. 3........	remainder	4–6	17–22	2.50	0.40	0.50*a*	....	....	....	3.0
Bell Metal.....	remainder	16–18	0.25*a*	0.25	0.25	0.25*a*	0.02	0.05	....	0.50
Babbitt Metal.	0.50*a*	9.25-10.75	remainder	none	....	14–16	....	....	0.20	0.75*c*
Lining Metal...	0.50*a*	4.50-5.50	remainder	none	....	9.25-10.75	....	....	0.20	0.75*c*

a Maximum.
b Not considered an impurity, and can be specified at option of purchaser.
c Must not contain zinc.

(*b*) Where no figures are given for impurity maximum, these elements may be present up to any amount to come within the total impurity specified, provided the material otherwise meets the chemical and physical tests. Where maximum percentages are specified, the elements referred to are considered as impurities and shall not be intentionally added.

Chemical Analysis. 3. An analysis will be made by the purchaser or his representative from one ingot, casting or journal bearing representing each lot. The chemical composition thus determined shall conform to the requirements specified in Section 2 for the particular alloy.

Sample for Chemical Analysis. 4. (*a*) *Ingots.*—Drillings shall be taken with a drill at least ½ in. in diameter at a point midway between the heaviest and smallest cross-section of the ingot. For ingots having two or more sections, drillings shall be taken from each section. In the case of Babbitt Metal and Lining Metal, drillings so taken shall be melted in a thoroughly cleaned ladle with a little rosin flux and poured into a piece of thin section. This piece shall be

sawed into three parts and the sawings therefrom thoroughly mixed to constitute the sample for chemical analysis.

(*b*) *Locomotive Castings.*—Drillings shall be taken with a drill as large as possible at such points in the casting as shall be thoroughly representative. Drillings through the skin shall be rejected. Drillings thoroughly mixed shall constitute the sample for chemical analysis.

(*c*) *Car and Tender Bearings.*—Drillings shall be taken with a drill at least ½ in. in diameter, at three points as widely separated as possible on the bearing selected for physical test as specified in Section 5 (*b*). Drillings representing the skin of the casting shall be rejected. These drillings, thoroughly mixed, shall constitute the sample for chemical analysis.

Drillings shall be taken in a like manner from the lining, exercising care that the drill does not penetrate the soldered surface.

(*d*) All samples, whether taken with a drill or saw, shall be kept free of oil and shall be carefully treated with a magnet to remove any iron introduced in taking the sample.

II. PHYSICAL INSPECTION AND TESTS.

Physical Inspection.

5. (*a*) *Locomotive Castings.*—The castings shall be sound, free from blowholes, flaws or shrinkage cracks, and shall show good foundry practice and workmanship.

One casting representing each lot of locomotive bearings will be broken by the purchaser or his representative for examination of fracture. The fracture shall disclose no shrink discoloration, segregation, dross or dirt spots within ⅝ in. of the bored journal engaging surface, and shall show no distinct signs of imperfect mixture.

(*b*) *Car and Tender Bearings.*—The bearings shall be sound, free from sand, blowholes, flaws or shrinkage cracks, and shall show good foundry practice and workmanship.

One bearing representing each lot will be broken by the purchaser or his representative for examination of fracture. The fracture shall show no shrink discoloration, segregation, dross or dirt spots within ½ in. of the bored journal engaging surface. This test shall be made before linings are applied. A

second test shall be made after application of the lining as follows:

(1) The suspended brass when tapped with a hammer shall give a distinct ring.

(2) The lining when chipped with a cold chisel shall tear from the soldered surface as distinguished from clean shearing.

III. LOT.

Lot.

6. (*a*) *Ingots.*—Each 5000 lb. or fraction thereof shall constitute a lot. The ingot from which the sample is taken shall be included in the shipment.

(*b*) *Locomotive Castings.*—Unless otherwise specified, each 100 castings or fraction thereof shall constitute a lot.

The manufacturer shall furnish, free of cost, one casting representing each lot for purpose of tests as specified in Sections 4 (*b*) and 5 (*a*).

(*c*) *Car and Tender Bearings.*—Unless otherwise specified, each 300 bearings or fraction thereof from each pattern shall constitute a lot.

The manufacturer shall furnish, free of cost, one bearing representing each lot for purpose of tests as specified in Sections 4 (*c*) and 5 (*b*).

IV. PERMISSIBLE VARIATIONS IN DIMENSIONS.

(FOR CAR AND TENDER BEARINGS ONLY.)

Permissible Variations.

7. (*a*) The purchaser will furnish drawings showing the dimensions of the bearings ordered and permissible variations therefrom, and the bearings shall conform to these drawings within such permissible variations.

(*b*) The thickness at the center of the brass and of the complete bearing shall not vary more than $\frac{1}{32}$ in. over or under the normal thickness shown on the drawing. The thickness of the lining shall not vary more than $\frac{1}{32}$ in. over or under the normal thickness shown on the drawing.

V. WORKMANSHIP.

Workmanship.

8. (*a*) *Locomotive Castings.*—The castings shall conform to the dimensions specified and shall show good workmanship generally.

(*b*) *Car and Tender Bearings.*—The bearings shall show good workmanship generally, and shall be free from mechanical imperfections. They shall be bored to a true radius, and with the axis parallel to the plane of the top and perpendicular to the side lugs and bearing flange. The lettering shall be clear and distinct. No emery shall be used on journal engaging surfaces on either the brass or the lining.

VI. MARKING.

9. (*a*) *Ingot.*—The manufacturer's marking only shall be required, unless otherwise specified. **Marking.**

(*b*) *Locomotive Castings.*—The lot number and other marks as required by the drawings shall be legibly marked on each casting.

(*c*) *Car and Tender Bearings.*—The name or initials of the manufacturer, the initials of the purchaser, type number, journal size, and lot number shall be legibly cast with raised figures on a depressed surface of each bearing, as shown on the drawings.

VII. INSPECTION AND REJECTION.

10. (*a*) Inspection may be made at the manufacturer's works where the ingots, locomotive castings or car and tender bearings are made, or at the point at which they are received, at the option of the purchaser. **Inspection.**

(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

11. Failure to meet the chemical or physical specifications, or non-conformity to any of the above requirements as to permissible variations, dimensions and markings, constitute sufficient cause for rejection of the lot represented by the sample chosen. **Rejection.**

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TENTATIVE SPECIFICATIONS
FOR
CARTRIDGE BRASS.[1]

Serial Designation: B 19 – 18 T.

These specifications are issued under the fixed designation B 19; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover sheet brass for making rifle and other small arms cartridge cases.

I. MANUFACTURE.

Components. 2. The brass shall be made from lake or electrolytic copper, meeting the requirements of the Standard Specifications for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars (Serial Designation: B-4) or the Standard Specifications for Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars (Serial Designation: B-5) of the American Society for Testing Materials, and zinc of Grades Nos. 1 or 2 of the Standard Specifications for Spelter (Serial Designation: B-6) of the American Society for Testing Materials.[2]

Scrap. 3. No scrap shall be used except that arising from the manufacture of brass or cases made from materials complying with the requirements of Section 2.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

[2] 1918 Book of A.S.T.M. Standards.

II. CHEMICAL PROPERTIES AND TESTS.

4. The brass shall conform to the following requirements as to chemical composition: **Chemical Composition.**

Copper	66.5 - 69.5 per cent
Lead	not over 0.07 "
Iron	" " 0.05 "
Other materials	" " 0.15 "
Zinc	Remainder.

5. Analyses may be made on each lot of 50,000 lb. or less. Drillings or millings shall be made from at least ten separate pieces, equal quantities being taken from each and thoroughly mixed. Samples so prepared shall be divided into three equal parts, each of which shall be placed in a sealed package, one for each party and one for an umpire, if necessary. **Chemical Analyses.**

6. (*a*) Analyses of separate pieces may be made by the purchaser. The copper, lead, and iron contents thus determined shall be as follows: **Check Analyses.**

Copper	66.0 - 70.0 per cent
Lead	not over 0.10 "
Iron	" " 0.08 "

(*b*) In case of dissatisfaction, resampling shall be done in the presence of representatives of both parties. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for each party and one for an umpire, if necessary.

III. PHYSICAL PROPERTIES AND TESTS.

7. The brass shall be so annealed that the average of ten Brinell hardness readings from a lot will be within the limits of 51 to 65, using a 10-mm. ball and a pressure of 500 kg. No individual test shall exceed the limits of 50 to 69. **Hardness Tests.**

IV. PERMISSIBLE VARIATIONS IN DIMENSIONS.

8. A permissible variation of ±0.002 in. from the specified thickness when measured ½ in. from the edge of the strip will be allowed. The width of the strip may vary ±0.010 in. **Dimensional Variations.**

Lengths. 9. Cartridge metal may be furnished in coils or flat strips as required. When furnished in flat strips, no strip shall be of less length than 60 per cent of that specified. No lot shall contain more than 40 per cent of such short lengths.

V. WORKMANSHIP AND FINISH.

Finish. 10. The metal shall be free from injurious external and internal defects of a nature which will interfere with the purpose for which it is intended. It shall be well pickled and free from dirt. Strips shall be substantially straight and flat.

VI. INSPECTION AND REJECTION.

Inspection. 11. The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

Rejection. 12. Material which fails to conform to these specifications will be rejected and the manufacturer shall be notified.

EXPLANATORY NOTES.

Section 7.—A comparative study of Brinell hardness and grain size indicates the following relations:

Grain Size, mm.	Equivalent Brinell Hardness Number.
0.150	47
0.111	49
0.100	49.7
0.098	50
0.087	51
0.075	$52\frac{1}{4}$
0.060	$54\frac{3}{4}$
0.058	55
0.050	$57\frac{1}{2}$
0.044	60
0.040	$62\frac{1}{2}$
0.034	65
0.030	68
0.029	69

As it is easier and quicker to take the Brinell hardness than to polish and etch samples for study with the microscope, the

Brinell hardness is much to be preferred. Furthermore,through straightening or flattening operations, cartridge metal may be hardened to an appreciable extent without affecting the grain size or producing any noticeable distortion.

Many operators in making rapid determinations of grain size slight the polishing and etch in strong acids, so that it is frequently impossible to distinguish between twinned crystals and separate crystals and a false grain count is obtained.

Section 10.—The differentiation between immaterial and injurious defects is a matter which requires a considerable degree of knowledge as to the causes of the various kinds of imperfections which are encountered in material of this character, as well as a thorough understanding of the effects thereof upon its further fabrication and use. In general, two classes may be readily distinguished, namely, those which are imposed and those which are inherent. In the former class are dents and scratches caused by blows or abrasion, and foreign matter which, adhering to the surface of the material, may have been rolled into it. Dents and scratches may be of considerable magnitude and still disappear completely in subsequent operations of fabrication. Similarly the presence of imposed foreign matter may be relatively unimportant. The point to be observed in this connection is that the presence of this class of defects is indicative of nothing beyond their presence.

Inherent defects are those which occur as a result of the presence either of gas or foreign matter included in the material during the process of casting. Metal is seldom entirely free from such defects and visual evidence of these argues the presence of others not visible. Experience is needed to determine whether any such encountered are of a magnitude and character sufficient to establish a departure from correct casting practice sufficient to disqualify the material.

A third character of defect, and one of a grave nature, is caused by failure to completely remove any piping which may have occurred in casting. The indications of this defect are, however, well pronounced and characteristic.

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TENTATIVE SPECIFICATIONS FOR CARTRIDGE BRASS DISKS.[1]

Serial Designation: B 20 – 18 T.

These specifications are issued under the fixed designation B 20; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover brass disks for making artillery cartridge cases.

I. MATERIAL.

Metal. 2. The disks shall be made of cartridge brass conforming to the requirements of the Tentative Specifications for Cartridge Brass (Serial Designation: B 19–18 T) of the American Society for Testing Materials; except as to dimensions and permissible variations thereof, which shall conform to the requirements specified in Section 3.

II. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Dimensional Variations. 3. (*a*) Variations in dimensions shall conform to the following limits:

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably, before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

Diameter.	Permissible Variation, in.	Gage.	Permissible Variation, in.
Up to 1 in., incl.	± 0.0025	Up to 0.150 in., incl.	± 0.0025
Over 1 to 3 in., incl.	± 0.003	Over 0.150 to 0.300 in., incl.	± 0.003
Over 3 to 6 in., incl.	± 0.004	Over 0.300 to 0.400 in., incl.	± 0.004
Over 6 to 8 in., incl.	± 0.005	Over 0.400 in.	± 0.005
Over 8 in.	± 0.0075		

(*b*) The thickness of disks should be measured not less than ½ in. from the edge and on the diameter at right angles to the direction in which the bar was rolled.

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TENTATIVE SPECIFICATIONS

FOR

NAVAL BRASS RODS FOR STRUCTURAL PURPOSES.[1]

Serial Designation: B 21 – 18 T.

These specifications are issued under the fixed designation B 21; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover naval brass rods of any uniform cross-section such as round, hexagonal, square, etc.

I. MANUFACTURE.

Process. 2. The rods shall be manufactured either by hot rolling or extrusion, finished by such cold drawing as may be required, and straightened.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The brass shall conform to the following requirements as to chemical composition:

Copper	59.00 – 62.00	per cent
Tin	0.50 – 1.50	"
Iron	not over 0.10	"
Lead	" " 0.30	"
Materials other than above	" " 0.10	"
Zinc	Remainder.	

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably, before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

4. Analyses may be made on each lot of 5000 lb. or less. Drillings or millings shall be made from at least four separate rods, equal quantities being taken from each rod and thoroughly mixed. Samples so prepared shall be divided into three equal parts, each of which shall be placed in a sealed package, one for each party and one for an umpire, if necessary. **Chemical Analyses.**

5. (*a*) Analyses of separate rods may be made by the purchaser. The copper content thus determined shall lie within the following limits: **Check Analyses.**

Copper.................................. 59 - 63 per cent.

(*b*) In case of dissatisfaction, the rod or rods shall be sampled in the presence of representatives of both parties. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for each party and one for an umpire, if necessary.

III. PHYSICAL PROPERTIES AND TESTS.

6. The rods shall conform to the following minimum requirements as to tensile properties: **Tension Tests.**

Diameter, or Distance between Parallel Faces.	Yield Point, lb. per sq. in.	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent.
Up to 1 in., incl.	31 000	62 000	25.0
Over 1 to $2\frac{1}{2}$ in., incl.	30 000	60 000	30.0
Over $2\frac{1}{2}$ to $3\frac{1}{2}$ in., incl.	25 000	56 000	35.0
Over $3\frac{1}{2}$ in.	22 000	54 000	40.0

7. The test specimen shall bend cold through 120 deg. to a radius equal to its diameter, without fracturing. **Bend Tests.**

8. The test specimen shall stand an immersion in a mercurous-nitrate solution containing 100 g. of mercurous nitrate and 13 cc. of nitric acid (sp. gr. 1.42) per liter for 15 minutes, without fracturing. **Strain Tests.**

9. (*a*) Tension test specimens shall be as nearly as possible of the same diameter, or distance between parallel faces, as the rods. **Test Specimens**

(*b*) Bend test specimens may be a piece of the full size

rod, or a piece 1 in. in width by ½ in. in thickness. In the case of bend test specimens of rectangular section, the edges may be rounded off to a radius equal to one-fourth of the thickness.

(c) Strain test specimens shall be of the full size of the rod, at least 12 in. long, and without bending, springing, polishing, or any other preparation. At least 9 in. of the length of the specimen shall be immersed in the solution.

Number of Tests.

10. (a) Rods shall be grouped into lots of not more than 5000 lb.

(b) One tension, one bend, and one strain test specimen shall be cut from one rod for each lot or fraction thereof.

(c) If any tension test specimen breaks outside the middle third of the gage length, a retest shall be allowed.

IV. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Dimensional Variations.

11. The diameter of round sections, or the distance between parallel faces in the case of other sections, shall not vary from that specified more than the following:

Diameter, or Distance between Parallel Faces.	Permissible Variation, in.	
	Rounds.	Other Shapes.
Up to ½ in., incl.	± 0.0015	± 0.003
Over ½ to 1 in., incl.	± 0.0020	± 0.004
Over 1 to 2½ in., incl.	± 0.0025	± 0.005
Over 2½ in.	± 0.0030	± 0.006

Lengths.

12. Rods, when ordered to any length, will be received in stock lengths, unless it is specifically stated that the lengths are to be exact. Stock lengths for all rods from ¼ to 1 in., inclusive, in diameter or thickness shall be as follows:

(a) When ordered in 12-ft. lengths, no lengths less than 8 ft.; when ordered in 10-ft. lengths, no lengths less than 6 ft.; when ordered in 8-ft. lengths, no lengths less than 6 ft.; when ordered in 6-ft. lengths, no lengths less than 4 ft.

(b) When ordered in the lengths given above, the weight of lengths less than the length ordered shall not exceed 40 per cent of any one shipment.

(*c*) For rods over 1 in. up to and including 2 in. in diameter or thickness, the lengths shall be random lengths from 4 to 10 ft.; for rods over 2 in. in diameter or thickness, special lengths are required, but no length shall be less than 4 ft.

V. WORKMANSHIP AND FINISH.

13. The rods shall be free from injurious defects, substantially straight and free from kinks and bends, and shall have a bright, smooth surface. **Finish.**

VI. INSPECTION AND REJECTION.

14. The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the rods are being furnished in accordance with these specifications. **Inspection.**

15. Rods which fail to conform to these specifications will be rejected and the manufacturer shall be notified. **Rejection.**

EXPLANATORY NOTES.

Section 1.—Material intended to be covered by these specifications is suitable for structural purposes, and may be used as rods, bolts, etc. It is capable of being forged hot, but is not free cutting.

Section 5.—Consumers sometimes desire to judge material on the results obtained by a single sample. Due to a variety of causes, the copper content of material of this character is subject to variations of considerable magnitude. Moreover the melting unit is small, or about two or three hundred pounds. To take care of these circumstances, it is necessary to have a wider tolerance for determinations on single samples than is the case where a composition sample is used. It is not necessary to restrict the tin, iron, and lead contents within narrow limits. Consequently the values given in Section 3 need not be changed for an individual sample.

Section 8.—Bars which have been properly straightened or sprung will have internal stresses so broken up as not to be in danger of splitting or cracking. The mercurous-nitrate test is designed to determine whether the internal stresses have been properly broken up and rendered safe.

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TENTATIVE SPECIFICATIONS

FOR

BRONZE BEARING METALS FOR TURNTABLES AND MOVABLE RAILROAD BRIDGES.[1]

Serial Designation: B 22 - 18 T.

These specifications are issued under the fixed designation B 22; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. (*a*) These specifications cover four classes of bronze bearing metals for turntables and movable railroad bridges.

(*b*) The purposes for which these classes are frequently used are as follows:

Class A, for contact with hardened steel disks under pressures over 1500 lb. per sq. in., for example, bearing metals, used in turntables and center-bearing swing bridges;

Class B, for contact with soft steel at low speeds under pressures not over 1500 lb. per sq. in., for example, trunnions and journals of bascule and lift bridges;

Class C, for ordinary machinery bearings;

Class D, for gears, worm wheels, nuts and similar parts which are subjected to other than compressive stresses.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

I. MANUFACTURE.

Process.

2. (*a*) The bronze shall be a homogeneous alloy of copper and tin. The copper shall conform to the requirements of the Standard Specifications for Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars (Serial Designation: B 5-13), or the Standard Specifications for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars, "high-resistance" grade (Serial Designation: B 4-13), of the American Society for Testing Materials.[1] The bronze shall be made from new metal, except that scrap of known composition produced by the foundry at which the bronze is cast may be used.

(*b*) Care shall be exercised that the metal is not overheated and that the temperature at pouring and the conditions of cooling are such as will be most likely to secure dense castings.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

3. The bronze shall conform to the following requirements as to chemical composition:

Elements Considered.	Class.			
	A	B	C	D
Copper, per cent	Remainder	Remainder	not over 82	not over 89
Tin, max., per cent	20	17	11	11
Lead, max., per cent	....	....	11	....
Zinc, max., per cent	....	....	....	2.25
Iron, max., per cent	....	....	....	0.2
Phosphorus, per cent	not over 1.0	not over 1.0	0.7-1.0	not over 0.25
Other elements, max., per cent	0.5	0.5	0.5	0.5

Chemical Analyses.

4. (*a*) An analysis of each melt may be made at the option of the purchaser and at the purchaser's expense. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.[2]

[1] 1918 Book of A.S.T.M. Standards.

[2] Material with a range of composition differing from that specified in Section 3, or containing elements not specified, may be used, provided the manufacturer shall submit in writing previous to the execution of the contract the range of composition of the material he proposes to use, and provided this range of composition shall be accepted by the purchaser.

(*b*) The compression test coupon shall be used for analysis.

III. PHYSICAL PROPERTIES AND TESTS.

Compression and Tension Tests.

5. (*a*) The bronze shall conform to the following requirements as to compressive and tensile properties:

Properties Considered.	Class.			
	A	B	C	D
Compression.				
Deformation limit, min., lb. per sq. in. . .	24 000	18 000	....	....
Permanent set in 1 in. under 100 000 lb. per sq. in., in.	0.06 – 0.12	0.10 – 0.20	....	....
Tension.				
Yield point, min., lb. per sq. in.	....	....	....	To be recorded
Tensile strength, min., lb. per sq. in.	....	....	....	33 000
Elongation in 2 in., min., per cent.	....	....	....	14

(*b*) The deformation limit in compression shall be determined as that load which produces a permanent set of 0.001 in. in the compression test specimen described in Section 6 (*b*).

(*c*) The yield point in tension shall be determined as the stress producing an elongation under load of 0.5 per cent, that is, 0.01 in. in a gage length of 2 in.

Test Specimens.

6. (*a*) A test bar of the form and dimensions shown in Fig. 1, to be used for the tension test specimen, and a suitable test bar for the compression test specimen, shall be an integral part of the casting, and shall be fed and cooled under the same conditions as the castings.

(*b*) Compression test specimens shall be cylinders 1 sq. in. in cross-sectional area and 1 in. high.

(*c*) Tension test specimens, turned from the test bar shown in Fig. 1, shall conform to the dimensions shown in Fig. 2. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

Number of Tests.

7. (*a*) One compression test shall be made from each melt for Class A and B castings; and one tension test from each melt for Class D castings. For castings of any grade weighing over 100 lb. finished, the specified tests shall be made for each casting.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

IV. FINISH.

8. The castings shall be sound, clean, and free from blowholes, porous places, cracks and other defects. **Finish.**

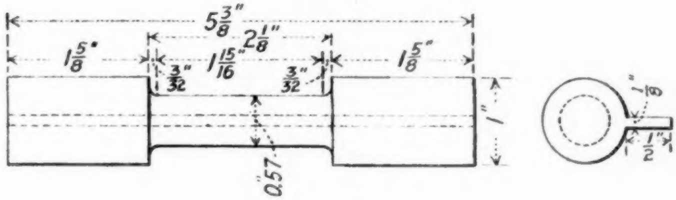
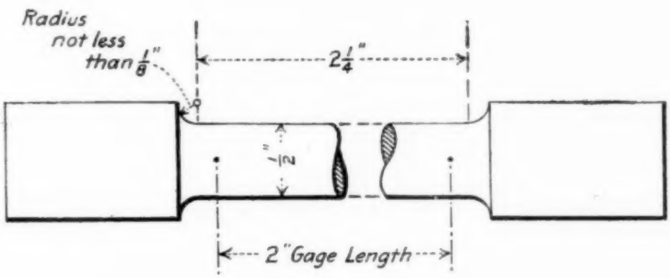


FIG. 1.



Note:– The Gage Length, Parallel Portions and Fillets shall be as Shown, but the Ends may be of any Form which will Fit the Holders of the Testing Machine.

FIG. 2.

V. INSPECTION AND REJECTION.

9. (*a*) Inspection may be made at the manufacturer's works where the castings are made, or at the point at which they are received, at the option of the purchaser. **Inspection.**

(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the purchaser shall have free entry, at all times while work on the contract

of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 10. Castings which show injurious defects revealed by machining operations subsequent to acceptance may be rejected, and if rejected, shall be replaced by the manufacturer free of cost to the purchaser. The full weight of the original material rejected shall be returned to the manufacturer.

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TENTATIVE SPECIFICATIONS

FOR

WHITE METAL BEARING ALLOYS (KNOWN COMMERCIALLY AS "BABBITT METAL").[1]

Serial Designation: B 23 – 18 T.

These specifications are issued under the fixed designation B 23; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered.

1. These specifications cover white metal bearing alloys, known commercially as "babbitt metal." Twelve typical babbitt metals are specified, covering the range of alloys commercially used, and are designated as Grades Nos. 1 to 12, in accordance with their decreasing tin content as specified in Section 4.

I. MANUFACTURE.

Uniform Quality.

2. The manufacturer shall use care to have each lot of babbitt metal as uniform in quality as possible.

Dimensions.

3. The standard bar, unless otherwise specified, shall have the following approximate dimensions:

Top face	$1\frac{1}{4}$ in. wide, $8\frac{1}{2}$ in. long.
Thickness	not over $1\frac{1}{4}$ in.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

4. The alloys shall conform to the following requirements as to chemical composition, within the limits specified in Section 5:

Alloy, Grade No.	Tin, per cent.	Antimony, per cent.	Lead, per cent.	Copper, per cent.	Iron, max., per cent.	Arsenic, max., per cent.	Zinc, per cent.	Aluminum, per cent.
1........	91	$4\frac{1}{2}$	0.35[a]	$4\frac{1}{2}$	0.08	0.10	none	none
2........	89	$7\frac{1}{2}$	0.35[a]	$3\frac{1}{2}$	0.08	0.10	none	none
3........	$83\frac{1}{3}$	$8\frac{1}{3}$	0.35[a]	$8\frac{1}{3}$	0.08	0.10	none	none
4........	75	12	10	3	0.08	0.15	none	none
5........	65	15	18	2	0.08	0.15	none	none
6........	20	15	$63\frac{1}{2}$	$1\frac{1}{2}$	0.08	0.15	none	none
7........	10	15	75	0.50[a]	....	0.20	none	none
8........	5	15	80	0.50[a]	....	0.20	none	none
9........	5	10	85	0.50[a]	....	0.20	none	none
10........	2	15	83	0.50[a]	....	0.20	none	none
11........	..	15	85	0.50[a]	....	0.25	none	none
12........	..	10	90	0.50[a]	....	0.25	none	none

[a] Maximum.

Permissible Variations.

5. The following permissible variations in the percentages of the desired elements specified in Section 4 will be allowed, but shall not apply to the maximum percentages of impurities specified:

Percentage of Element Specified.	Permissible Variations Over or Under the Specified Value, Units of Per Cent.
Not over 2 per cent	0.25
Over 2 to 5 per cent, incl	0.50
Over 5 to 10 per cent, incl	0.75
Over 10 per cent	1.00

Sample for Chemical Analysis.

6. (*a*) Three bars shall be selected to represent a shipment of less than 1000 lb., five bars to represent a shipment of over 1000 lb. to 10,000 lb., inclusive, and ten bars to represent a shipment of over 10,000 lb. to one carload.

(*b*) Saw cuts shall be made at points in the bars indicated

in Fig. 1. No lubricants shall be used for sawing. The sawings shall be carefully treated with a magnet to remove any particles of steel introduced in taking the sample.

(*c*) Sawings thoroughly mixed shall constitute the sample for chemical analysis.

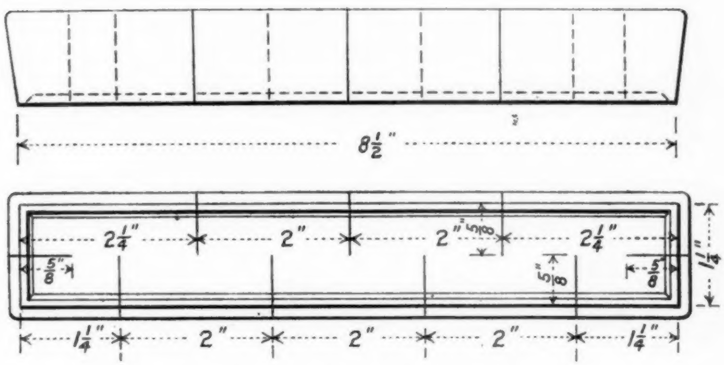

FIG. 1.—Method of Sampling.

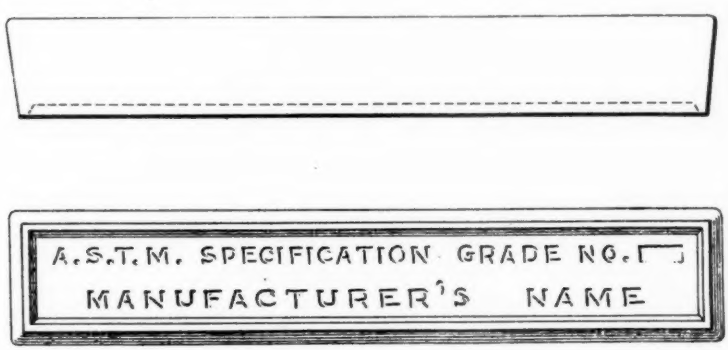

FIG. 2.—Preferred Arrangement of Marking.

Methods of Chemical Analysis.

7. The chemical analysis shall be made in accordance with the Tentative Methods for Chemical Analysis of Alloys of Lead, Tin, Antimony and Copper (Serial Designation: B 18–17 T) of the American Society for Testing Materials.

III. MARKING.

Marking.

8. The name of the manufacturer shall be cast on each bar. The numerical designation of the grade supplied shall be stamped or cast on each bar for identification.

(NOTE.—A preferred arrangement of marking is shown in Fig. 2.)

IV. CLAIMS.

Claims.

9. Claims, to be considered, shall be made in writing within thirty days of receipt of material at the purchaser's plant, and the results of the purchaser's tests shall be given. The shipper shall within one week of receipt of such claim, either agree to satisfy the claim or send a representative to the purchaser's plant to resample the shipment, as specified in Section 6. Samples so taken shall be sealed and submitted to a mutually agreeable umpire, whose determination shall be final.

Settlement of Claims.

10. The expense of umpire analysis shall be paid by the loser, or divided in proportion to the concession made in case of a compromise. In case of rejection being established, the damages shall be limited to the payment of freight both ways by the manufacturer for the substitution of an equivalent weight of babbitt metal meeting these specifications.

APPENDIX.

The data in the following table do not constitute a part of these specifications. They are given merely to indicate to the purchaser the physical properties of the various alloys specified which can be expected of carefully manufactured alloys of the formulas indicated, and to constitute a guide to the purchaser in selecting the grade best suited for meeting the service condition for which the babbitt metal is to be used. These figures are subject to revision.

In view of the shortage of tin it is recommended that lead-base metals be used wherever possible.

TABLE SHOWING PHYSICAL PROPERTIES OF WHITE METAL BEARING ALLOYS.

Alloy No.	Formula.				Deformation of Cylinder $1\frac{1}{4}$ in. Diam. by $2\frac{1}{2}$ in. High at 70° F., in.			Brinell Hardness.		Melting Point.		Complete Liquation Point.		Specific Gravity.	Weight.		Proper Pouring Temperature, deg. Fahr.
	Copper, per cent.	Tin, per cent.	Antimony, per cent.	Lead, per cent.	At 1000 lb.	At 5000 lb.	At 10 000 lb.	At 70° F.	At 212° F.	Deg. Fahr.	Deg. Cent.	Deg. Fahr.	Deg. Cent.		Oz. per cu. in.	Grams per cu. in.	
1....	4.5	91.0	4.5	....	0.000	0.001	0.015	28.6	12.8	437.0	225	699.8	371	7.34	4.24	120.28	824
2....	3.5	89.0	7.5	....	0.0000	0.0015	0.0120	28.3	12.7	460.4	238	683.6	362	7.39	4.27	121.10	808
3....	$8\frac{1}{3}$	$83\frac{1}{3}$	$8\frac{1}{3}$	....	0.0010	0.0045	0.0070	34.4	15.7	462.2	239	791.6	422	7.46	4.31	122.25	916
4....	3.0	75.0	12.0	10.0	0.0005	0.0025	0.0090	29.6	12.8	365.0	185	555.8	291	7.52	4.35	123.23	680
5....	2.0	65.0	15.0	18.0	0.0010	0.0030	0.0090	29.6	11.8	365.0	185	536.0	280	7.75	4.48	127.00	661
6....	1.5	20.0	15.0	63.5	0.0015	0.0050	0.0180	24.3	11.1	365.0	185	512.6	267	9.33	5.39	152.89	638
7....	..	10.0	15.0	75.0	0.0010	0.0050	0.0230	24.1	11.7	464.0	240	500.0	260	9.73	5.62	159.44	625
8....	..	5.0	15.0	80.0	0.0020	0.0090	0.0620	20.9	10.8	469.4	243	500.0	260	10.04	5.80	164.52	625
9....	..	5.0	10.0	85.0	0.0040	0.0120	0.0840	19.5	8.6	469.4	243	491.0	255	10.24	5.92	167.80	616
10....	..	2.0	15.0	83.0	0.0010	0.0100	0.1540	17.0	8.9	473.2	245	500.0	260	10.07	5.82	165.02	625
11....	..	..	15.0	85.0	0.0010	0.0100	0.1190	17.0	9.9	476.8	247	500.0	260	10.28	5.94	168.46	625
12....	..	..	10.0	90.0	0.0025	0.0170	0.2850	14.3	6.4	476.8	247	509.0	265	10.67	6.17	174.85	634

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TENTATIVE SPECIFICATIONS

FOR

ALUMINUM INGOTS FOR REMELTING AND FOR ROLLING.[1]

Serial Designation: B 24 – 18 T.

These specifications are issued under the fixed designation B 24; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover two grades of aluminum, as follows:

Grade A, containing not less than 99.0 per cent aluminum.
Grade B, containing not less than 98.0 per cent aluminum.

I. SAMPLING.

Sampling. 2. One ingot of each heat shall be taken for analysis, and in any case not less than one sample ingot from each 500 lb. (226.8 kg.) of metal.

Samples shall be obtained by drilling completely through the ingot or half through from top to bottom. The weight

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

of the samples obtained by drilling the ingot or ingots should not be less than 30 g.

II. PHYSICAL DEFECTS.

Physical Defects. 3. Ingots for rolling shall be substantially free from shrink holes, cold sets, pits and similar defects in set or casting. Such defects are of no consequence in ingots which are to bere melted.

III. CLAIMS.

Claims. 4. (*a*) Claims, to be considered, shall be made in writing within thirty days of receipt of aluminum at the purchaser's plant, and the results of the purchaser's tests shall be given. The refiner shall be given one week from date of receipt of such claim to investigate his records, and shall then either agree to replace the defective aluminum or send a representative to the plant. No claims shall be considered unless made as above stated, and if the aluminum in question, unused, cannot be shown to the refiner's representative.

(*b*) In a question of metal contents each party shall select a sample of two pieces. These shall be drilled in the presence of both parties, several holes approximately $\frac{1}{2}$ in. in diameter being drilled completely through each piece; scale from set shall not be rejected. No lubricant shall be used and drilling shall not be forced sufficiently to cause oxidation of chips. The resulting samples shall be cut up, mixed, and separated into three parts, each of which shall be placed in a sealed package, one for each party and one for the umpire if necessary. Each party shall make an analysis, and if the results do not establish or dismiss the claim to the satisfaction of both parties the third sample shall be submitted to a mutually agreeable umpire, who shall determine the question of fact, and whose determination shall be final.

Settlement of Claims. 5. The expense of the shipper's representative and of the umpire shall be paid by the loser, or divided in proportion to the concession made in case of compromise. In case of rejection being established, the damages shall be limited to payment of freight both ways by the refiner for the substitution of an equivalent weight of aluminum meeting these specifications.

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TENTATIVE SPECIFICATIONS FOR ALUMINUM SHEET.[1]

Serial Designation: B 25 – 18 T.

These specifications are issued under the fixed designation B 25; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

I. MANUFACTURE.

Manufacture.

1. No scrap shall be used in the manufacture of aluminum sheet except such as shall accumulate at the manufacturer's own plant from material of the same composition and of his own manufacture.

II. CHEMICAL PROPERTIES AND TESTS.

2. The sheet may be rolled from aluminum ingots of Grade A, described in the Tentative Specifications for Aluminum Ingots for Remelting and for Rolling (Serial Designation: B 24–18 T) of the American Society for Testing Materials.

Chemical Analysis.

3. Samples for analysis shall be obtained from a random sheet, representing each 500 lb. (226.8 kg.) of aluminum or any lot weighing less than 500 lb. (226.8 kg.), as agreed upon between

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

the seller and the purchaser. Samples so prepared shall be divided into three equal parts, each of which shall be placed in a sealed package, one for each party and one for an umpire if necessary. The sample for analysis may be prepared by shearing.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

4. (*a*) Sheets may be furnished in either of three tempers or degrees of hardness and shall conform to the following requirements as to tensile properties:

TEMPER No. 1; SOFT, ANNEALED.

B. & S. Gage.	Thickness, in.	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent.
12 to 16, incl.	0.0808 - 0.0509	12 500	30
17 " 22, "	0.0508 - 0.0227	12 500	20
23 " 26, "	0.0226 - 0.0159	12 500	10
TEMPER No. 2; HALF-HARD.			
12 to 16, incl.	0.0808 - 0.0509	18 000	7
17 " 22, "	0.0508 - 0.0227	18 000	5
23 " 26, "	0.0226 - 0.0159	18 000	5
TEMPER No. 3; HARD.			
12 to 16, incl.	0.0808 - 0.0509	22 000	4
17 " 22, "	0.0508 - 0.0227	25 000	2
23 " 26, "	0.0226 - 0.0159	30 000	2

(*b*) The tension test specimen shall be taken parallel to the direction of cold rolling of the sheet.

Bend Tests.

5. Sheets of temper No. 1 shall withstand being bent double in any direction and hammered flat, and sheets of temper No. 2, being bent around a pin of radius equal to the thickness of the sheet, without cracking.

Number of Tests.

6. (*a*) One tension and one bend test specimen shall be cut from a random sheet representing each 500 lb. (226.8 kg.) of aluminum or any lot weighing less than 500 lb. (226.8 kg.), as agreed upon between the seller and the purchaser.

(*b*) Test specimens may be used for purposes of analysis specified in Section 3.

IV. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Dimensional Variations. 7. The thickness of sheets shall not vary from that specified by more than the following amounts:

B. & S. Gage.	Thickness, in.	Permissible Variation, in.
10 to 17, incl.	0.1019 - 0.0404	0.003
18 " 26, "	0.0403 - 0.0159	0.002

V. WORKMANSHIP AND FINISH.

Workmanship. 8. All sheets shall be commercially flat and free from buckles; they shall be free from injurious surface defects and shall have a workmanlike finish.

VI. INSPECTION AND REJECTION.

Inspection. 9. The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

Rejection. 10. Material which fails to conform to these specifications will be rejected and the manufacturer shall be notified.

Explanatory Notes.

Section 4.—Aluminum sheet cut in other directions than parallel to the direction of cold rolling will show a ductility less than that in this direction; the elongation at right angles to the direction of cold rolling may be only two-thirds of the former.

It is strongly recommended that a self-centering tension test specimen holder be used for testing particularly thin gages of hard aluminum sheet, in view of the lack of uniformity which may occur in test series made in the usual wedge grips.

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TENTATIVE SPECIFICATIONS

FOR

LIGHT ALUMINUM CASTING ALLOYS.[1]

Serial Designation: B 26 – 18 T.

These specifications are issued under the fixed designation B 26; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered.

1. These specifications cover commercial light alloys of aluminum having a specific gravity of 3 and less.

I. MANUFACTURE.

Process.

2. The alloy may be made by any approved method.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition

3. The following alloys are described by these specifications; they shall conform to the following requirements as to chemical composition:

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

Alloy.	Copper, per cent.	Zinc, per cent.	Manganese, per cent.	Total Impurities, per cent.	Aluminum, per cent.
A	7 - 8.5	......	......	1.7	Remainder
B	8.5 - 11	......	......	1.7	Remainder
C	11 - 14	......	......	1.7	Remainder
D	2.5 - 3.0	12.5 - 14.5	......	1.7[a]	Remainder
E	2 - 2.5	......	0.75 - 1.25	1.0	Remainder

[a] Lead content shall not be greater than 0.1 per cent.

Sampling. 4. (*a*) The sample for chemical analysis may be taken either by sawing, drilling or milling the casting or tension test specimen and shall represent the average cross-section of the piece.

(*b*) The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation, and the sawdust or metal chips shall be carefully treated with a magnet to remove any particles of iron introduced in taking the sample.

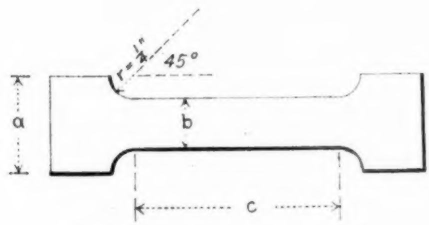
III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 5. The alloys shall conform to the following minimum requirements as to tensile properties:

Alloy.	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent.
A	18 000	1
B	18 000	..
C	19 000	..
D	22 000	..
E	18 000	8

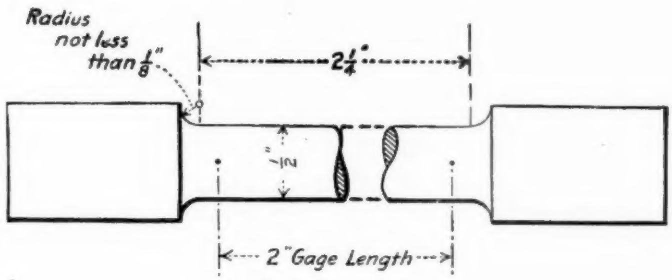
Test Specimens. 6. (*a*) Two test bars of the form and dimensions shown in Fig. 1 shall be an integral part of large castings, or cast separately in the case of small castings to represent a lot or melt, and shall be molded in a manner similar to the castings which they represent. If the castings are heat-treated, the test bars representing such castings shall be similarly heat-treated.

(*b*) The manufacturer and purchaser shall agree whether test bars can be attached to castings, on the location of the bars on the castings, on the castings to which bars are to be attached, and on the method of casting unattached bars.



a ---- 1 in.
b --- not greater than $\frac{5}{8}$ in., nor less than $\frac{1}{2}$ in.
c --- not less than $2\frac{1}{8}$ in.

FIG. 1.



Note:– The Gage Length, Parallel Portions and Fillets shall be as Shown, but the Ends may be of any Form which will Fit the Holders of the Testing Machine.

FIG. 2.

(*c*) Tension test specimens, turned from the test bar shown in Fig. 1, shall conform to the dimensions shown in Fig. 2. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

Number of Tests.

7. (*a*) Tests shall as far as possible be made by heats or melts, but unless otherwise agreed, two tension tests shall be made upon each unit lot of 500 lb. or single delivery of less than 500 lb.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

IV. INSPECTION AND REJECTION.

Inspection. 8. (*a*) Inspection may be made at the manufacturer's works where the castings are made, or at the point at which they are received, at the option of the purchaser.

(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 9. Castings which show injurious defects revealed by machining operations subsequent to acceptance may be rejected, and if rejected, shall be replaced by the manufacturer free of charge to the purchaser. The full weight of the original material rejected shall be returned to the manufacturer.

EXPLANATORY NOTES.

The alloys described may be divided into two groups: those (A, B, C, D) having a relatively high hardness, as evidenced by the proportional limit, but little or no ductility; and E, which has a relatively low proportional limit, but a fair ductility. Thus the alloys A and D are quite suitable for general castings which, although highly stressed in service, will not likely be subjected to overstress. If a casting is likely to be subjected to a very rough treatment tending to overstress it, a more ductile alloy, E, is to be preferred.

Alloys B and C are suitable for high temperature and pressure service. Alloy B is recommended for pistons, alloy C

for manifolds, carburetors, pumps, etc. Average values for other physical properties of these alloys are given in the following table:

PHYSICAL PROPERTIES OF ALUMINUM ALLOYS.

Alloy.	Density, g. per cc.	Shrinkage, in. per ft.	Temperature, Melting Range.		Proportional Limit, lb. per sq. in.
			Deg. Cent.	Deg. Fahr.	
A	2.89	0.156	637 - 540	1146 - 972	about 10 000
B	2.95	0.156	630 - 540	1133 - 972	....
C	3.00	0.156	623 - 540	1120 - 972	....
D	3.00	0.156	625 - 440	1124 - 792	....
E	2.79	0.156	649 - 529	1166 - 952	less than 2 000

Section 5.—The elongations obtained with Alloys B, C and D are generally less than 1 per cent and are too small to be satisfactorily measured.

Section 6.—Some latitude has been allowed in the diameter of the cast test bars; test bars cast to size are stronger than those which are machined, and the tensile properties specified can be obtained under usual conditions only with the cast-to-size bar.

It is strongly recommended that a self-centering form of tension test specimen holder be used. Most aluminum alloys (A, B, C, D) are brittle and give lower and less uniform test results when tested in ordinary wedge grips without centering.

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TENTATIVE METHODS

FOR

CHEMICAL ANALYSIS OF ALLOYS OF LEAD, TIN, ANTIMONY AND COPPER.[1]

Serial Designation: B 18 – 17 T.

These methods are issued under the fixed designation B 18; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

I. GENERAL METHOD.[2]

1. Dissolve 1 g. of the finely divided alloy by boiling in from 70 to 100 cc. of the following solution in a covered beaker: The solution is made by dissolving 20 g. of KCl in 500 cc. of water, then adding 400 cc. of concentrated HCl, mixing, and then 100 cc. of HNO_3 (sp. gr. 1.40). No decomposition between HCl and HNO_3 takes place in this solution in the cold. If complete solution of the alloy is difficult in the amount of the solution taken, more is added as required. Continue boiling until solution is evaporated to about 50 cc.

Lead. (*a*) Add 5 cc. of concentrated HCl and cool by placing beaker in ice water until the bulk of the lead has crystallized out as

[1] Criticisms of these Tentative Methods are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

[2] G. W. Thompson's method. See *Journal*, Soc. Chem. Ind., Vol. 15, p 179.

chloride. Then add slowly 50 cc. of 95-per-cent alcohol from a pipette, with constant stirring; stir for a few minutes longer after the alcohol has been added and place the beaker in ice water for ten minutes. Add 50 cc. more alcohol in the same way, allow to stand in ice water for 20 minutes and filter through 9-cm. paper into an 800-cc. beaker. Wash by decantation three times with a mixture of 95-per-cent alcohol and concentrated HCl (4 : 1) and wash paper twice with same mixture. With proper manipulation this treatment should uniformly precipitate all but 0.003 g. of lead. The most favorable conditions are obtained by allowing to stand, cold, over night before adding the alcohol.

Wash the lead chloride on paper back into beaker and wash paper several times with hot water, allowing washings to flow into beaker with the rest of the chloride. Finally, wash twice with a solution of hot ammonium acetate (the ammonium-acetate solution is made by taking one volume of ammonia water 0.900 sp. gr., adding to it one volume of water, and then 80-per-cent acetic acid until it is slightly acid to litmus) and heat until lead chloride is all dissolved. The solution should remain perfectly clear, turbidity indicating the presence of tin or antimony; even 1 mg. of tin or antimony will cause a slight but distinct turbidity. Add 15 cc. of saturated solution of $K_2Cr_2O_7$, heat until precipitate is of good orange color, filter on weighed Gooch crucible, wash with water, alcohol and ether, dry at 110° C., and weigh. Calculate to lead by the empirical factor 63.75.

Evaporate the filtrate from lead chloride by boiling on hot plate in the loosely covered 800-cc. beaker, and finally to dryness on water bath, with cover removed. Add 10 cc. of the solution of KOH (1 g. to 5 cc.) and after a few minutes 20 cc. of 3-per-cent H_2O_2. Test the solution by dropping into it a small piece of litmus paper, and, if acid, add more KOH, little by little, until it shows an alkaline reaction. Heat on water bath for 20 minutes, add 10 g. of ammonium oxalate, 10 g. of oxalic acid, and 200 cc. of water. Heat to boiling, pass H_2S with solution near boiling for 45 minutes, filter at once, and wash precipitate with hot water.

(*b*) Concentrate, if necessary, or if the tin in the portion of **Tin.**

the sample taken for analysis amounts to 0.5 g. or over, add 5 g. more oxalic acid, and electrolyze over night, using cylindrical cathodes 2 by $1\frac{3}{8}$ in. diameter, of platinum wire gauze, with a current of about $\frac{1}{2}$ ampere. Usually by morning the solution will have become alkaline, in which case it may be taken for granted that the tin is all precipitated on the cathode. The best results are obtained, however, by regulating the current density so as to render the solution alkaline only a very short time before the cathode is to be removed; and it is desirable as a precaution to add 5 g. of oxalic acid after the solution has become alkaline, boil and re-electrolyze. Remove the cylinder, wash twice with water, and then with 95-per-cent alcohol, dry in oven, and weigh. Wash the precipitate of antimony and copper sulfides on the filter paper back into the beaker with the least amount of water possible and treat with 10 cc. of KOH solution (1 : 5), heat on a water bath until the undissolved matter is distinctly black, then filter through same paper it was washed from into a 12-oz. Erlenmeyer flask, wash, etc.

Copper. (*c*) On filter the copper is obtained as sulfide with a small amount of lead which failed to be precipitated as chloride. (If it is desired to determine this lead, it can be done by separation from the copper as usual.) Dry and ignite precipitate in small casserole, dissolve in HNO_3, boil to expel nitrous fumes, neutralize with Na_2CO_3, add a few drops of ammonia, and determine volumetrically with KCN standardized against pure copper. If the amount of copper present is from 8 to 10 mg. or more, it is determined electrolytically in HNO_3 solution, and the small amount of lead may be obtained and weighed on the anode as dioxide.

If only small amounts (less than 10 mg.) of antimony and copper are present in the sample, the lead, which failed to be precipitated as chloride, may also fail to come down as sulfide on passing H_2S through the oxalic-acid solution. It will remain in the filtrate from the sulfides and will be deposited electrolytically with the tin on the cathode. This can be prevented by adding an oxalic-acid solution of a pure antimony salt equivalent to about 100 mg. of antimony just before passing H_2S. In this case antimony, if present in the sample, must be determined on a separate portion.

(*d*) The solution of antimony sulfide in KOH should not amount to over 40 cc.; add 50 cc. of concentrated HCl and boil for some time in order to expel arsenic as arsenious chloride. Now add 25 cc. more of concentrated HCl and 1 g. $KClO_3$, boil until solution is colorless and free chlorine is driven off, filter into similar flask through mineral wool if sulfur has separated, wash out original flask with concentrated HCl, cool, add 1 g. of KI, 1 cc. of CS_2, and titrate for antimony with N/10 sodium-thiosulfate solution, 1 cc. of which equals 0.0060 g. of antimony. **Antimony.**

This systematic method assumes the absence of other metals than lead, tin, antimony, and copper.

2. *Determination of Arsenic.*—Arsenic is determined on a separate portion as follows: Weigh out 1 g. of the finely divided sample and transfer to a distillation flask, together with 10 cc. of ferric-chloride solution (sp. gr. 1.43) free from arsenic; 60 cc. of concentrated HCl; 20 cc. of water; 5 g. of KCl. Connect the flask with a condenser, heat slowly until solution is complete, and distill, boiling to as small a volume as possible. When cool add 50 cc. more concentrated HCl and redistill. Pass H_2S through the cold distillate for an hour, allow to settle, filter and weigh the arsenious sulfide on a Gooch crucible, washing with HCl, cold water, alcohol and CS_2. After drying and weighing, redissolve with ammonium-carbonate solution, wash thoroughly with water and reweigh the Gooch crucible, calculating the loss in weight to arsenic. **Arsenic.**

II. RAPID VOLUMETRIC METHODS FOR FACTORY CONTROL WORK.

DETERMINATION OF LEAD.

(MOLYBDATE METHOD.)

3. Treat 1 g. of the finely divided alloy in a covered beaker with 2 to 5 g. of tartaric acid and 10 cc. of water. Add slowly with constant stirring 10 cc. of HNO_3 (1 : 1) and heat gently—not above 60° C.—until the bulk of the sample is dissolved. Complete the solution (of antimony and copper) by heating on steam bath, and, if necessary, adding two or three drops of HNO_3 (concentrated). This treatment should give a clear solution, with formation of no metastannic acid (H_2SnO_3). Add **Lead.**

slowly 10 cc. of H_2SO_4 (1 : 1) with constant stirring and then evaporate until nitrous fumes are no longer given off; but the evaporation should be stopped before the tartaric acid begins to char. Cool, dilute and filter off lead sulfate, washing with dilute H_2SO_4 (1 : 10).[1] Place the precipitate and filter in a flask, add 10 cc. of strong HCl and boil until the filter is well disintegrated, then add 15 cc. of strong HCl, 25 cc. of cold water and 25 cc. of strong ammonia water, Now color with a little litmus solution, make slightly alkaline with ammonia if not already so, and then make distinctly acid with strong acetic acid. Heat to boiling and see that the lead sulfate is entirely dissolved, then dilute to about 200 cc. with boiling-hot water and titrate with standard ammonium-molybdate solution as follows: Pour about two-thirds of the hot lead solution into a large beaker and run the molybdate solution into it from a burette until a drop from the beaker, when placed on a glazed porcelain plate and touched with a drop of a solution of tannic acid (about 0.1 g. dissolved in 20 cc. of water), gives a brown or yellow tinge. Now add more of the lead solution from the flask and continue the titration until the end-point is again passed. Continue thus to approach the true end-point, using more caution each time. Finally, when only a few cubic centimeters remain in the flask, pour the entire mixture in the beaker into the flask and then back into the beaker again and finish the titration two drops at a time. When the final yellow tinge is obtained, some of the immediately preceding tests may have developed a tinge also. From the reading of the burette deduct the volume of two drops for each test thus showing a color. Multiply the corrected reading by the percentage value of 1 cc. of the molybdate solution in lead to obtain the percentage of lead in the sample.[2]

The ammonium-molybdate solution is made by dissolving about 4.74 g. of ammonium molybdate in water and making up to one liter. It is standardized by treating about 0.2 g. of pure lead foil in exactly the same way as described for the treatment of the sample. This method is not accurate for alloys containing less than 2 per cent of lead.

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[1] See "The Analysis of Non-Ferrous Alloys," Ibbotson and Aitchison. p. 192, Method II. and "Technical Analysis of Brass," Price and Meade. p. 156.

[2] "Technical Methods of Ore Analysis," A. H. Low, pp. 129 and 131.

Determination of Tin.

(Pearce-Low Iodine Method.)

4. Weigh 0.2 to 1.0 g. (depending on the percentage of tin) of the finely divided alloy into a 12-oz. wide-mouth conical flask. Add 20 cc. of concentrated HCl and when most of the soluble metal is dissolved add $KClO_3$, a little at a time, until solution is complete. Boil off all the chlorine and then add 50 to 75 cc. of concentrated HCl, depending on the amount of antimony present. Make the solution up to a volume of 200 cc. with water. Prepare a nickel coil by rolling 6 sq. in. of heavy sheet nickel ($1\frac{1}{2}$ by 4 in.) into a loose roll of such a size that it may be easily inserted into the flask. Leave a narrow strip of nickel attached to one side of the coil and long enough to reach above the top of the flask when the coil is on the bottom. Place the coil in the solution in the flask, bend the nickel strip over the edge and cover with a small watch glass. Heat to boiling and maintain gentle ebullition for 30 minutes after all the iron which may be in the solution is reduced, which may be told by the yellow color of the solution changing to a pale green. Remove the flask from the hot plate and at once, while the solution is still hot and hydrogen still being evolved, place the rubber stopper carrying the tube from a CO_2 generator in the neck of the flask. Start the current of CO_2 and place the flask in the cooling trough. Tin.

When the solution in the flask has cooled to room temperature remove the stopper and drop in two $\frac{1}{2}$-in. cubes of crystallin marble. Remove the nickel coil, washing it with cold HCl solution (1 strong acid : 3 water), as it is withdrawn from the flask. This washing solution must be boiled to expel any free chlorine and then cooled before using. Add a little starch solution and titrate at once with standard iodine solution until the characteristic blue color indicates the end point.

The standard iodine solution most convenient for this titration is prepared by dissolving 10.7 g. of iodine in 50 cc. of water containing 20 g. of KI in solution, and making up to one liter with water. This can be standardized with pure tin or with a solution of sodium thiosulfate of exactly known value.[1]

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[1] See "The Volumetric Determination of Tin," R. L. Hallett, *Journal*, Soc. Chem. Ind., Vol. XXXV, No. 21.

DETERMINATION OF ANTIMONY.

(LOW'S PERMANGANATE METHOD.)

Antimony. 5. Treat 1 g. of the finely divided alloy in a 300-cc. Kjeldahl flask with 10 to 15 cc. of concentrated H_2SO_4 and heat over a Bunsen flame until the alloy is thoroughly decomposed and all separated sulfur has been driven off. Do not drive off all free H_2SO_4, but have from 7 to 10 cc. left to keep the melt from getting hard on cooling. Cool, add 20 cc. of water and 20 cc. of concentrated HCl and boil to make sure that all SO_2 is driven off. If arsenic is present in the alloy in only small amounts as an impurity it will be volatilized here and not interfere with the determination of antimony. However, the solution should in no case reach a temperature of 120° C. or over after the addition of HCl or there is danger of volatilizing antimony chloride. Cool and add water to a total volume of 200 cc., adjusting the strength of HCl to 1 : 10 for small amounts of antimony, or 1 : 5 for larger amounts. Titrate the cold solution rapidly with $KMnO_4$ solution, which has been standardized against pure metallic antimony treated exactly as described above for determination of the alloy. The true end point is reached when the whole solution is colored pink by one drop after agitation. The end point is sharp but the color may soon disappear, owing to the amount of HCl present.[1]

DETERMINATION OF COPPER.

Copper. 6. Dissolve 1 g. of the fine sawings in a No. 3 beaker in 45 cc. of strong HCl and 5 cc. of strong HNO_3. Boil down to about 15 or 20 cc. to expel free chlorine. Remove from the plate and wash down the sides of the beaker and cover glass with a fine jet of HCl (sp. gr. 1.10) from a wash bottle, using as little as possible. Dilute with water to about 75 cc. and add 5 g. of tartaric acid dissolved in 15 or 20 cc. of water. Make alkaline with ammonia till a clear blue solution is obtained and then add strong HCl drop by drop till the blue changes to light green and a slightly acid solution is obtained. If any lead chloride remains undissolved, heat on the plate a little below boiling

[1] See "Determination of Antimony and Tin," W. H. Low. *Journal*, Am. Chem. Soc., Vol. XXIX, p. 66; and "Rapid Analysis of Babbitt Metal," Percy H. Walker and H. A. Whitman, *Journal of Industrial and Engineering Chemistry*, Vol. I, p. 519.

till it is in solution. The solution should now be clear and hot. Add 2 cc. of stannous-chloride solution (225 g. to 1000 cc. of 1.10 HCl). Follow at once with 0.5 g. of potassium sulfocyanate dissolved in a little water. The copper precipitates completely as CuSCN and in a perfectly pure condition, barring a fractional part of a milligram of lead that seems to be carried down. Warm on the hot plate for a few minutes and filter through a single paper containing a little paper pulp. Wash thoroughly with hot water.[1]

Dry and ignite the precipitate in a small porcelain casserole or crucible, dissolve in a small amount of HNO_3, and boil to expel nitrous fumes. If the copper in the sample amounts to less than 8 to 10 mg., determine volumetrically with KCN as described under "General Method." If the amount of copper present is from 8 to 10 mg. or more, determine volumetrically as cuprous iodide, as follows:

Transfer the HNO_3 solution of copper to a flask of 250 cc. capacity, add 5 cc. of strong bromine water and boil until all nitrous fumes and bromine are expelled. Add a slight excess of ammonia and boil the excess off, then add strong acetic acid in slight excess, cool, add 3 g. of KI and titrate at once with N/10 sodium-thiosulfate solution until the free iodine is nearly removed, then add some starch liquor and continue the titration cautiously until the color due to free iodine has entirely vanished.[2]

[1] Method of separation used by R. S. MacPherran, Chief Chemist, Allis-Chalmers Manufacturing Co.

[2] "Technical Methods of Ore Analysis," A. H. Low, p. 79.

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TENTATIVE METHODS
FOR
CHEMICAL ANALYSIS OF MANGANESE BRONZE.[1]

Serial Designation: B 27 - 18 T.

These methods are issued under the fixed designation B 27; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

GENERAL CONSIDERATIONS.

Methods are given for the determination of lead, using a large sample when lead is present up to about 0.2 per cent. A method is also given for the electrolytic determination of lead and copper in the same small sample when lead is present in amounts over 0.2 per cent.

In this alloy zinc is taken by difference. For a method of determining small amounts of zinc, see Tentative Methods for Chemical Analysis of Gun Metal (Serial Designation: B 28–18 T) of the American Society for Testing Materials.

[1] Criticisms of these Tentative Methods are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

DETERMINATION OF COPPER

BY THE

ELECTROLYTIC METHOD.

APPARATUS FOR ELECTROLYSIS.

Electrodes.—The electrodes recommended are of the stationary and not of the rotating type, as the stationary require less operator's time and there is less chance for erroneous results to be obtained than with the other kind. Rapid and accurate results are obtained with stationary electrodes made from platinum gauze.

Cathodes.—Platinum cathodes may be formed either from plain or perforated sheets, or from wire gauze, and may be either open or closed cylinders. They should give a depositing surface, counting both sides, of approximately 100 sq. cm. Gauze cathodes are recommended, and are best made from gauze containing approximately 400 meshes per sq. cm. (45 meshes per linear inch). The cathode should be stiffened by doubling the gauze for about 3 mm. at the top and at the bottom of the cylinder. The cylinder should be approximately 30 mm. in diameter and 30 mm. in height. The stem should be made from 1.14-mm. or 1.29-mm. wire, flattened and welded the entire width of the gauze; the height over all should be approximately 130 mm., and the gauze should be sand blasted.

Anodes.—Platinum anodes may be of the spiral type when used in the determination of copper by electrolysis, or in the electrolytic determination of lead when it is present in amounts not over 0.2 per cent. When used in electrolytic determination of copper and lead together in samples containing 0.2 per cent lead or over, the anodes should be of wire gauze. Spiral anodes should be made from 1.02-mm. or 1.14-mm. wire formed into a spiral of 7 turns having a height of approximately 51 mm. and a diameter of 16 mm., the length over all being approximately 145 mm. Platinum gauze used in making anodes should contain approximately 400 meshes per sq. cm. (45 meshes per linear inch). The gauze should be formed into closed cylinders approximately 12 mm. in diameter and 30 mm. in height. The

cylinders should be stiffened by doubling the gauze for about 3 mm. at the top and at the bottom. The stem should be made from 1.02-mm. or 1.29-mm. wire, flattened and welded the entire width of the gauze; the height over all should be approximately 137 mm., and the gauze should be sand blasted.

METHOD.

In a 150-cc. beaker dissolve 1 g. of bronze in 10 cc. of HNO_3, sp. gr. 1.42. When the action has ceased, evaporate the solution to dryness, and bake thoroughly on the edge of a hot plate. Moisten thoroughly with HNO_3, sp. gr. 1.42, and after digesting for a short time dilute to 50 cc. with hot distilled water, heat to boiling, and allow to stand and settle for about one hour, keeping the temperature just below the boiling point. Filter on double 7-cm. papers, keeping the solution hot, and receive the filtrate in a 200-cc. electrolysis beaker. Wash with boiling hot water. Add to the filtrate 5 cc. of H_2SO_4, sp. gr. 1.84, and evaporate until copious fumes of H_2SO_4 are evolved. Dilute to about 100 cc. with distilled water, add 1.5 cc. of HNO_3, sp. gr. 1.42, insert electrodes, cover with a pair of split watch-glasses and electrolyze. For each solution use a current over night of 0.5 ampere at approximately 10 volts, or else use a current of 4 amperes at approximately 10 volts continued for about $2\frac{1}{2}$ hours. The latter case requires the use of gauze cathodes. When the solution is colorless, wash down cover glasses, electrodes, and sides of beaker, raising the level of the liquid slightly and continue the electrolysis about 15 minutes, noting whether or not copper is deposited on the newly exposed surface of the platinum. If no copper appears, transfer about 1 cc. of the colorless solution to the cavity of a porcelain test plate, and add a few drops of fresh H_2S water. If the slightest discoloration occurs continue the electrolysis, repeating the test. Remove the cathode quickly, rinse it in distilled water and then dip it in two successive baths of alcohol. Shake off the excess alcohol and ignite the remainder by bringing it to the flame of an alcohol lamp. Keep the cathode moving continually as the alcohol burns. Weigh as metallic copper.

Accuracy.—Duplicate determinations should check within 0.10 per cent of copper.

NOTES.

In alloys of the type of manganese bronze, which carry considerable iron, it is impossible to remove the tin quantitatively as metastannic acid (H_2SnO_3), notwithstanding the preliminary baking. Upon testing (by the addition of H_2S water), the liquid in the pits of the test plate may be colored yellow, due to the tin present, but there should be no darkening due to the presence of copper. If the cathode appears dark, as though tin had been deposited on it, dissolve the coating in 10 cc. of HNO_3, sp. gr. 1.42, filter off the tin as before, add to the filtrate 5 cc. of H_2SO_4, sp. gr. 1.84, and redeposit copper by electrolysis. It is rarely necessary thus to purify the deposited copper.

If zinc is to be determined in the alloy be careful to keep the solution quantitative when the electrodes are removed, catching all washings in the beaker containing the electrolyte.

A slight amount of copper is retained by the metastannic acid (H_2SnO_3), which should be recovered in very accurate work but is generally neglected in routine analysis.

DETERMINATION OF LEAD BY THE ELECTROLYTIC METHOD.

(FOR SAMPLES CONTAINING UP TO 0.2 PER CENT OF LEAD.)

METHOD.

In a 250-cc. beaker dissolve 5 g. of bronze in 25 cc. of HNO_3, sp. gr. 1.42. Allow the solution to bake dry on the edge of a hot plate or by standing over night on the steam bath. Add 17 cc. of HNO_3, sp. gr. 1.42, and after digesting for a short time, add 85 cc. of hot water and heat to boiling for a few minutes. Allow the solution to stand for several hours at a temperature just below the boiling point. Filter off the precipitated H_2SnO_3 on double closely woven filter papers, being careful to keep the solution hot throughout the process of filtration. Wash with boiling hot water. Receive the combined filtrate and washings in a 250-cc. beaker. Dilute to about 150 cc. with distilled water and insert electrodes. In the positive terminal use a sand-blasted platinum gauze electrode such as is used for the cathode in the determination of copper: in the negative terminal insert an electrode such as is used for the anode in the determination of copper. Cover with a pair of

split watch glasses and electrolyze. For each solution use a current of 1.25 to 1.5 amperes at 10 volts continued for about one hour. Wash down the cover glasses, electrodes and sides of beaker, raising the level of the liquid slightly, and continue the electrolysis for 15 minutes. If no darkening of the newly exposed surface of the platinum can be detected the lead has been entirely deposited. Continue the electrolysis until no darkening of the platinum can be detected when the current has been passed for 15 minutes after the level of the liquid has been raised.

When the lead has been entirely deposited, remove the anode quickly, rinse it in distilled water and then in alcohol, and dry it at 210° C. for one-half hour. Weigh as PbO_2, using the factor for lead 0.8643 instead of the theoretical value.

Accuracy.—Duplicate determinations should check within 0.01 per cent of lead. Results obtained by this method are likely to be about 0.01 per cent too high. For exceptionally accurate or investigation work redissolve the coating from the electrode and determine the lead as sulfate. See the "Determination of Lead as Sulfate."

NOTES.

It is impossible to remove the tin quantitatively as H_2SnO_3 in the case of alloys containing over 0.25 per cent of iron, and traces of tin are sometimes found in the PbO_2 deposit. Small amounts of manganese also are occasionally deposited with the PbO_2. Tin and manganese are rarely present in the PbO_4 in amounts which necessitate a purification of the deposit.

In this and the following method a slight amount of lead may be retained by the H_2SnO_3. This should be recovered in very accurate work, but is neglected in routine analysis.

DETERMINATION OF LEAD AS SULFATE.

(FOR SAMPLES CONTAINING UP TO 0.2 PER CENT OF LEAD.)

(OPTIONAL.)

SOLUTIONS REQUIRED.

"*Lead Acid.*"—Mix 300 cc. of H_2SO_4, sp. gr. 1.84, and 1800 cc. of distilled water. Dissolve 1 g. of lead acetate, c. p.,

in 300 cc. of distilled water and add this to the hot solution, stirring meanwhile. Let stand at least 24 hours and syphon through a thick asbestos filter.

Dilute Alcohol for Washing.—Mix equal parts of denatured alcohol and distilled water.

METHOD.

In a 250-cc. beaker dissolve 5 g. of bronze in 25 cc. of HNO_3, sp. gr. 1.42. Allow the solution to bake dry on the edge of a hot plate, or by standing over night on the steam bath. Add 17 cc. of HNO_3, sp. gr. 1.42, and after digesting for a short time, add 85 cc. of hot water and heat to boiling for a few minutes. Allow the solution to stand for several hours at a temperature just below the boiling point. Filter off the precipitated H_2SnO_3 on double closely woven filter papers, being careful to keep the solution hot throughout the process of filtration. Wash with boiling hot water. To the combined filtrate and washings add 120 cc. of lead acid, and evaporate until copious fumes of H_2SO_4 are evolved. Cool, add 105 cc. of distilled water to dissolve the salts and to make the acid concentration the same as in lead acid, heat to boiling, and allow to cool and settle for 5 hours, or over night if convenient. Filter on a weighed porcelain gooch crucible and wash with lead acid. Wash out the lead acid with dilute alcohol, set the Gooch crucible inside a porcelain crucible, dry and ignite for 5 minutes at the full heat of a Tirrill burner, cool and weigh as $PbSO_4$, which contains 68.29 per cent lead.

Accuracy.—Duplicate determinations should check within 0.01 per cent of lead. Results obtained by this method are likely to be about 0.01 per cent too low.

NOTE.

It is impossible to remove the tin quantitatively as H_2SnO_3 in the case of alloys containing over 0.25 per cent of iron, but by the preliminary baking and long standing, most of the H_2SnO_3 is precipitated.

DETERMINATION OF COPPER AND LEAD SIMULTANEOUSLY BY THE ELECTROLYTIC METHOD.

(FOR SAMPLES CONTAINING OVER 0.2 PER CENT OF LEAD.)

METHOD.

In a 150-cc. beaker dissolve 1 g. of bronze in 10 cc. of HNO_3, sp. gr. 1.42. When the action has ceased, evaporate the solution to dryness, and bake thoroughly on the edge of a hot plate. Add 10 cc. of HNO_3, sp. gr. 1.42, and after digesting for a short time add 50 cc. of hot distilled water, heat to boiling, and allow to stand and settle for about one hour, keeping the temperature just below the boiling point. Filter on double 7-cm. filter papers, keeping the solution hot, and receive the filtrate in a 200-cc. electrolysis beaker. Wash with boiling hot water, dilute to about 100 cc. and insert electrodes. In the positive terminal insert one of the platinum gauze anodes previously described, and in the negative terminal insert a platinum gauze cathode. Cover with a pair of split watch glasses and electrolyze, using a current of from 3 to 5 amperes at approximately 10 volts for each solution. After about 45 minutes the lead will have been entirely deposited on the anode as PbO_2; without interrupting the current add to the electrolyte 3 to 4 cc. of H_2SO_4, sp. gr. 1.84, and continue the electrolysis. When the solution is colorless, wash down cover glasses, electrodes and sides of beaker, raising the level of the liquid slightly, and continue the passage of the current about 15 minutes, noting whether or not copper is deposited on the newly exposed surface of the platinum. If no copper appears, transfer about 1 cc. of the colorless solution to the cavity of a porcelain test plate, and add a few drops of fresh H_2S water. If the slightest discoloration occurs continue the electrolysis until there is no discoloration whatever upon repeating the test. Remove the solution from the electrodes quickly without interrupting the current. Rinse the electrodes in distilled water and then dip them in two successive baths of alcohol. Dry the anode at 210° C. for one-half hour. Weigh as PbO_2, using the factor for lead 0.8643 instead of the theoretical value.

Shake off the excess alcohol from the cathode and ignite the remainder by bringing it to the flame of an alcohol lamp. Keep the cathode moving continually while the alcohol burns. Weigh as metallic copper.

Accuracy.—Duplicate copper determinations should check within 0.10 per cent of copper. Duplicate lead determinations should check within 0.02 per cent of lead. Lead results obtained by this method are likely to be about 0.01 per cent too high. See notes under the "Determination of Lead by the Electrolytic Method."

DETERMINATION OF TIN.

SOLUTIONS REQUIRED.

Dilute Hydrochloric Acid.—Mix 500 cc. of HCl, sp. gr. 1.20, and 500 cc. of distilled water.

Dilute Sulfuric Acid.—Mix 300 cc. of H_2SO_4, sp.gr., 1.84, and 600 cc. of distilled water.

Dilute Ammonia.—Mix 100 cc. of NH_4OH, sp. gr. 0.90, and 900 cc. of distilled water.

Ammonium-Acetate Solution for Washing.—Dissolve 10 g. of ammonium acetate in 300 cc. of distilled water. Make slightly acid with acetic acid and saturate with H_2S gas.

METHOD.

In a 150-cc. beaker dissolve 2 g. of bronze in a mixture of 10 cc. of HCl, sp. gr. 1.20, and 5 cc. of HNO_3, sp. gr. 1.42. Dilute to about 75 cc. with distilled water. Add NH_4OH, sp. gr. 0.90, until the basic salts of copper have dissolved and the solution has become a deep blue. Boil and allow to settle, and filter on a closely woven filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitate on the filter with hot dilute HCl. Dilute the solution to about 100 cc. Add NH_4OH, sp. gr. 0.90, until a permanent precipitate forms. Heat the solution to boiling, allow to settle, filter and wash as before. Dissolve the precipitate on the filter with boiling hot

dilute H_2SO_4, washing the paper very thoroughly with this acid. Add NH_4OH, sp. gr. 0.90, cautiously until the precipitate which forms at first dissolves rather slowly. Allow the solution to stand for some hours and if any lead sulfate forms filter it off. Dilute the solution to about 200 cc. and saturate it with H_2S gas. Filter the precipitated tin sulfide off on double papers and wash with ammonium-acetate solution, retaining the filtrate and washings for the iron determination. Dry the precipitate and place it with the papers in a porcelain crucible which projects part way through a hole in a piece of asbestos board. Heat slowly until any free sulfur has been driven off, but without allowing the sulfur to burn. When the sulfur has been expelled, place the crucible on a triangle and ignite slowly at first and finally at the full heat of the burner. If the precipitate weighs more than 20 mg. heat to constant weight, using a blast lamp. Weigh as SnO_2, which contains 78.81 per cent of tin.

Accuracy.—Duplicate determinations should check within 0.06 per cent of tin.

NOTES.

If, during ignition, the sulfur is allowed to burn, some tin sulfate may be formed, causing high results. On the other hand, low results may be caused by too high heat, which causes spattering and volatilizes some tin sulfide.

Tin and iron are best determined on the same sample, retaining the filtrate from the tin sulfide precipitate to use for the iron determination.

DETERMINATION OF IRON.

SOLUTIONS REQUIRED.

See "Determination of Tin," and the following:

Dilute Sulfuric Acid for Reductor.—Mix 50 cc. of H_2SO_4, sp. gr. 1.84, and 1000 cc. of distilled water. This solution is used boiling hot.

Potassium Permanganate.—Dissolve 0.2 g. of $KMnO_4$ in water, filter through asbestos, and dilute to 1000 cc. with distilled water. Standardize against 0.020-g. portions of pure sodium oxalate. Each cubic centimeter is equivalent to approximately 0.00033 g. of iron.

METHOD.

Proceed exactly as in the "Determination of Tin" through the filtration and washing of the precipitated tin sulfide. Combine the filtrate and washings from the tin sulfide precipitate and boil until all H_2S is expelled. Add HNO_3, sp. gr. 1.42, until the iron is oxidized, which is shown by the solution becoming clear and of a yellowish color. Add about 5g. of NH_4Cl, then NH_4OH, sp. gr. 0.90, until a permanent precipitate forms. Boil, allow to settle, filter on a loosely woven filter paper and wash with dilute ammonia and with hot water. Dissolve the precipitate on the paper with hot dilute HCl and add NH_4OH, sp. gr. 0.90, to the solution again until a permanent precipitate forms. Boil, allow to settle, filter on a loosely woven filter paper, and wash with dilute ammonia and with hot water until all NH_4Cl is removed. Dissolve the precipitate and wash the filter paper with 100 cc. of dilute H_2SO_4 for reductor. Pass the solution through a Jones reductor, wash first with 150 cc. of the H_2SO_4 for reductor and then with 100 cc. of distilled water. Titrate with the standard $KMnO_4$ solution.

Accuracy.—Duplicate determinations should check within 0.03 per cent of iron.

NOTES.

A blank determination should be made on corresponding amounts of acid and water passed through the reductor and the results should be corrected accordingly. About 0.5 cc. of the permanganate will be required to give a permanent coloration to the solution.

A small quantity of liquid should always be left in the reductor funnel, and air should never be allowed to enter the body of the reductor.

For description and further details of use of reductor see "The Chemical Analysis of Iron" by A. A. Blair, or "Quantitative Chemical Analysis" by H. P. Talbot.

DETERMINATION OF MANGANESE BY THE PERSULFATE METHOD.

SOLUTIONS REQUIRED.

Solution for Dissolving.—Mix 500 cc. of H_2SO_4, sp. gr. 1.84, 200 cc. of HNO_3, sp. gr. 1.42, and 1700 cc. of distilled water.

Silver Nitrate.—Dissolve 1.33 g. of $AgNO_3$ in 1000 cc. of distilled water.

Stock Sodium Arsenite.—To 15 g. of arsenious oxide (As_2O_3) in a 300-cc. Erlenmeyer flask, add 45 g. of Na_2CO_3 and 150 cc. of distilled water. Heat the flask and contents on the steam bath until the As_2O_3 is dissolved. Cool the solution, filter and make up to 1000 cc. with distilled water.

Standard Sodium Arsenite.—Mix 200 cc. of stock sodium-arsenite solution with 2500 cc. of distilled water, and standardize against a steel or iron of known manganese content as determined by the Bismuthate Method, or standardize against one of the Bureau of Standards' standard irons or steels. One cc. of this solution should be equivalent to approximately 0.00050 g. of manganese.

Ammonium Persulfate.—Dissolve 60 g. of ammonium persulfate in 1000 cc. of distilled water.

METHOD.

In a 250-cc. Erlenmeyer flask dissolve 1 g. of bronze in 24 cc. of the "solution for dissolving". Allow to stand on a steam bath or hot plate until entirely dissolved, and until the oxides of nitrogen are expelled. Add 15 cc. of $AgNO_3$ solution and 20 cc. of ammonium persulfate and leave on the steam bath until the solution has developed a full permanganate color and no bubbles can be seen to come off when the flask is given a whirling motion. Cool to below 25° C. in running water, and add 50 cc. of cold water. Titrate with standard sodium-arsenite solution to the disappearance of the pink color.

Accuracy.—Duplicate determinations should check within 0.02 per cent of manganese.

NOTES.

Large amounts of permanganic acid are unstable; on that account, samples which contain large amounts of manganese should have correspondingly small samples weighed out. For instance, with metal containing 1.5 per cent of manganese use a 0.10-g. sample, while if metal contains 0.75 per cent manganese use a 0.20-g. sample.

The solution must be cold when it is titrated, for high temperatures cause low results to be obtained.

DETERMINATION OF MANGANESE BY THE BISMUTHATE METHOD.

(OPTIONAL.)

SOLUTIONS REQUIRED.

Nitric Acid (1:3).—Mix 250 cc. of HNO_3, sp. gr. 1.42, and 750 cc. of distilled water.

Nitric Acid for Washing.—Mix 30 cc. of HNO_3, sp. gr. 1.42, and 970 cc. of distilled water.

Ferrous Ammonium Sulfate.—Dissolve 12.4 g. of ferrous ammonium sulfate crystals in 950 cc. of distilled water, and add 50 cc. of H_2SO_4, sp. gr. 1.84.

Potassium Permanganate.—Dissolve 1 g. of $KMnO_4$ in 1000 cc. of distilled water. Allow it to stand for about one week and then filter it through asbestos. Standardize against 0.10-g. portions of pure sodium oxalate.

METHOD.

In a 250-cc. Erlenmeyer flask dissolve 1 g. of bronze in 50 cc. of HNO_3 (1:3). Without filtering off the H_2SnO_3, cool and add 0.5 g. of sodium bismuthate. Heat for a few minutes until the purple color has disappeared, with or without the precipitation of manganese dioxide. Add a little ferrous ammonium sulfate solution until the solution becomes clear, and boil until the oxides of nitrogen are expelled. Cool, add an excess of sodium bismuthate and agitate for a few minutes. Add 50 cc.

of HNO_3 for washing and filter through an alundum crucible or an asbestos pad. Wash with 50 cc. of the HNO_3 for washing. Add from a pipette or a burette 10 cc. of ferrous ammonium sulfate solution and titrate with $KMnO_4$. Owing to the presence of considerable copper, the end point is somewhat different from the normal pink color.

In exactly the same manner carry through a blank determination, using the same amounts of HNO_3 and sodium bismuthate as was done with the regular sample. Finally add exactly 10 cc. of ferrous ammonium sulfate solution and titrate with $KMnO_4$. The difference between the two titrations is due to the manganese. Since one manganese as permanganate oxidized five irons, the iron value of the permanganate multiplied by the factor $\frac{Mn}{5\ Fe}$ (or 0.1967) gives the value in terms of manganese.

Accuracy.—Duplicate determinations should check within 0.02 per cent of manganese.

NOTES.

Instead of employing the method of reducing the permanganic acid by means of standardized ferrous ammonium sulfate solution and titrating the excess of this reagent, it is possible to reduce the permanganic acid by standard sodium-arsenite solution. See "Determination of Manganese by the Persulfate Method."

The filtrate from the bismuthate must be perfectly clear, as the least particle of bismuthate carried into the filtrate will vitiate the results.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE METHODS

FOR

CHEMICAL ANALYSIS OF GUN METAL.[1]

Serial Designation: B 28 – 18 T.

These methods are issued under the fixed designation B 28; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

GENERAL CONSIDERATIONS.

Phosphorus should not be present in this alloy except in very small amounts. A rapid qualitative test for it is given whereby it is easily seen whether or not it is necessary to make a correction for its presence in the determination of tin.

A special method is also given for the determination of tin in alloys such as phosphor-bronze which contain considerable phosphorus.

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[1] Criticisms of these Tentative Methods are solicited and should be directed, preferably before January 1, 1919, to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

DETERMINATION OF COPPER BY THE ELECTROLYTIC METHOD.

APPARATUS FOR ELECTROLYSIS.

Electrodes.—The electrodes recommended are of the stationary and not of the rotating type, as the stationary require less operator's time and there is less chance for erroneous results to be obtained than with the other kind. Rapid and accurate results are obtained with stationary electrodes made from platinum gauze.

Cathodes.—Platinum cathodes may be formed either from plain or perforated sheets, or from wire gauze, and may be either open or closed cylinders. They should give a depositing surface, counting both sides, of approximately 100 sq. cm. Gauze cathodes are recommended, and are best made from gauze containing approximately 400 meshes per sq. cm. (45 meshes per linear inch). The cathode should be stiffened by doubling the gauze for about 3 mm. at the top and at the bottom of the cylinder. The cylinder should be approximately 30 mm. in diameter and 30 mm. in height. The stem should be made from 1.14-mm. or 1.29-mm. wire, flattened and welded the entire width of the gauze; the height over all should be approximately 130 mm., and the gauze should be sand blasted.

Anodes.—Platinum anodes may be of the spiral type when used in the determination of copper by electrolysis, or in the electrolytic determination of lead when it is present in amounts not over 0.2 per cent. When used in electrolytic determination of copper and lead together in samples containing 0.2 per cent lead or over, the anodes should be of wire gauze. Spiral anodes should be made from 1.02-mm. or 1.14-mm. wire formed into a spiral of 7 turns having a height of approximately 51 mm. and a diameter of 16 mm., the length over all being approximately 145 mm. Platinum gauze used in making anodes should contain approximately 400 meshes per sq. cm. (45 meshes per linear inch). The gauze should be formed into closed cylinders approximately 12 mm. in diameter and 30 mm. in height. The

cylinders should be stiffened by doubling the gauze for about 3 mm. at the top and at the bottom. The stem should be made from 1.02-mm. or 1.29-mm. wire, flattened and welded the entire width of the gauze; the height over all should be approximately 137 mm., and the gauze should be sand blasted.

METHOD.

In a 150-cc. beaker dissolve 1 g. of gun metal in 10 cc. of HNO_3, sp. gr. 1.42. When the action has ceased, boil until the oxides of nitrogen are expelled, add 50 cc. of hot distilled water, and allow to stand and settle for about one hour, keeping the temperature just below the boiling point. Filter on double 7-cm. ashless papers, being careful to keep the solution hot throughout the process of filtration, and receiving the filtrate in a 200-cc. beaker of the tall type used in electrolysis. Wash with boiling hot water. Retain the papers containing the precipitate for subsequent use in the tin determination.

Add to the filtrate 5 cc. of H_2SO_4, sp. gr. 1.84, and determine copper by electrolysis, retaining the electrolyte, after the removal of the copper, for the subsequent determination of zinc. See the "Determination of Copper by the Electrolytic Method," Tentative Methods for Chemical Analysis of Manganese Bronze (Serial Designation: B 27-18 T) of the American Society for Testing Materials.

Accuracy.—Duplicate determinations should check within 0.10 per cent of copper.

NOTES.

Copper, zinc, and tin are conveniently determined on the same sample, tin being first removed, and any zinc tested for after copper has been deposited by electrolysis.

If the solution becomes cool during the first filtration some of the metastannic acid (H_2SnO_3) may dissolve.

DETERMINATION OF TIN.

(FOR SAMPLES FREE FROM PHOSPHORUS.)

METHOD.

See the "Determination of Copper by the Electrolytic Method."

Use the papers containing the H_2SnO_3 which was filtered off in the Determination of Copper by the Electrolytic Method. Ignite the papers with the precipitate, while moist, in a porcelain or platinum crucible, slowly at first, and finally at the full heat of the burner. If the precipitate weighs more than 20 mg. heat to constant weight, using a blast lamp. Weigh as SnO_2, which contains 78.81 per cent of tin.

Accuracy.—Duplicate determinations should check within 0.04 per cent of tin.

This method is not accurate for alloys which contain arsenic, antimony or phosphorus, or which contain over 0.25 per cent of iron. The SnO_2 may be contaminated with a slight amount of copper and purification is required in very accurate work, but is generally neglected in routine analysis.

The ignited tin oxide contains any phosphorus which may be present in the alloy. The following test is here made use of to detect phosphorus and to estimate its amount, if any is found.

QUALITATIVE TEST FOR PHOSPHORUS.

SOLUTIONS REQUIRED.

Ferric Chloride.—Dissolve 25 g. of ferric chloride in 100 cc. of distilled water, and add 25 cc. of HCl, sp. gr. 1.20.

METHOD.

Dip a small piece of the alloy into a few cubic centimeters of ferric chloride for about 10 seconds, and then rinse it in running water. Alloys containing phosphorus are darkened noticeably where they have been dipped; alloys containing over 0.25 per

cent of phosphorus are rendered almost black by this test. Arsenic and antimony act in a manner similar to phosphorus, but should not be present in this alloy.

CORRECTION FOR PHOSPHORUS.

In alloys containing up to 0.20 per cent of phosphorus a correction for its presence in the ignited tin oxide may be made according to the following empirical method. From the phosphorus content of the alloy, which must be determined on a separate sample, compute the weight of P_2O_5 and subtract two-thirds of this weight from the weight of the ignited tin oxide containing phosphorus. The remainder is considered as pure SnO_2, which contains 78.81 per cent of tin. The factor for converting phosphorus to $\frac{2}{3}$ x P_2O_5 is 152.6 per cent or approximately one and one-half times the phosphorus content of the sample.

If the alloy contains over 0.20 per cent of phosphorus a special method for the determination of tin should be used.

Arsenic and antimony should not be present in weighable amounts in the tin oxide resulting from a sample of gun metal.

Iron may be present in the H_2SnO_3 in very small amounts, but its weight is negligible in this determination.

In alloys which contain over 0.25 per cent of iron, use the method for the Determination of Tin in Manganese Bronze, Tentative Methods for Chemical Analysis of Manganese Bronze (Serial Designation: B 27-18 T) of the American Society for Testing Materials.

DETERMINATION OF TIN.

(FOR SAMPLES CONTAINING PHOSPHORUS.)

SOLUTIONS REQUIRED.

Yellow Ammonium Sulfide.—Saturate 150 cc. of NH_4OH, sp. gr. 0.90, with H_2S gas and then add 50 cc. more NH_4OH. Dissolve in this solution 3 or 4 g. of sulfur flour and about 1 g. of NH_4Cl. Make up this solution freshly and filter immediately before using.

Dilute Yellow Ammonium Sulfide for Washing.—Mix 20 cc. of yellow ammonium sulfide, prepared as above, and 400 cc. of distilled water.

Ammonium Acetate for Washing.—Dissolve 10 g. of ammonium acetate in 300 cc. of distilled water, make slightly acid with acetic acid and saturate with H_2S gas.

METHOD.

See the "Determination of Copper by the Electrolytic Method."

Use the papers containing the freshly filtered H_2SnO_3 which was filtered off in the Determination of Copper by the Electrolytic Method. Transfer the papers with the precipitate to a 150-cc. beaker, and cover them with 40 to 50 cc. of yellow ammonium sulfide. Warm for about 15 minutes, or until the H_2SnO_3 has dissolved. Filter and wash thoroughly with dilute yellow ammonium sulfide. Acidify the combined filtrate and washings cautiously with 50-per-cent acetic acid. Warm, and allow the precipitated tin sulfide and sulfur to settle. Filter on double papers and wash with ammonium-acetate solution. Dry the precipitate, and place it with the papers in a porcelain crucible which projects part way through a hole in a piece of asbestos board. Heat slowly until the free sulfur has been driven off, but without allowing the sulfur to burn. When the sulfur has been expelled, place the crucible on a triangle and ignite slowly at first, and finally at the full heat of the burner. If the precipitate weighs more than 20 mg., heat to constant weight, using a blast lamp. Weight as SnO , which contains 78.81 per cent of tin.

Accuracy.—Duplicate determinations should check within 0.06 per cent of tin.

NOTES.

If during the first filtration the solution becomes cool, some of the H_2SnO_3 may dissolve.

During ignition, if the sulfur is allowed to burn, some tin sulfate may be formed, causing high results. On the other hand, low results may be caused by too high heat, which causes spattering, and volatilizes some tin sulfide.

DETERMINATION OF LEAD BY THE ELECTROLYTIC METHOD.

(For Samples Containing up to 0.2 per cent of Lead.)

Method.

In a 250-cc. beaker dissolve 5 g. of gun metal in 25 cc. of HNO_3, sp. gr. 1.42. Allow the solution to bake dry on the edge of a hot plate or by standing over night on the steam bath. Add 17 cc. of HNO_3, sp. gr. 1.42, and after digesting for a short time, add 85 cc. of hot water and heat to boiling for a few minutes. Allow the solution to stand for several hours at a temperature just below the boiling point. Filter off the precipitated H_2SnO_3 on double closely woven filter papers, being careful to keep the solution hot throughout the process of filtration. Wash with boiling hot water. Receive the combined filtrate and washings in a 250-cc. beaker. Dilute to about 150 cc. with distilled water and insert electrodes. In the positive terminal use a sand-blasted platinum gauze electrode such as is used for the cathode in the determination of copper; in the negative terminal insert an electrode such as is used for the anode in the determination of copper. Cover with a pair of split watch glasses and electrolyze. For each solution use a current of 1.25 to 1.5 amperes at 10 volts continued for about one hour. Wash down the cover glasses, electrodes and sides of beaker, raising the level of the liquid slightly, and continue the electrolysis for 15 minutes. If no darkening of the newly exposed surface of the platinum can be detected the lead has been entirely deposited. Continue the electrolysis until no darkening of the platinum can be detected when the current has been passed for 15 minutes after the level of the liquid has been raised.

When the lead has been entirely deposited, remove the anode quickly, rinse it in distilled water and then in alcohol, and dry it at 210° C. for one-half hour. Weigh as PbO_2, using the factor for lead 0.8643 instead of the theoretical value.

Accuracy.—Duplicate determinations should check within 0.01 per cent of lead. Results obtained by this method are likely to be about 0.01 per cent too high. For exceptionally accurate or investigation work redissolve the coating from the electrode and determine the lead as sulfate. See the "Determination of Lead as Sulfate."

NOTES.

It is impossible to remove the tin quantitatively as H_2SnO_3 in the case of alloys containing over 0.25 per cent of iron, and traces of tin are sometimes found in the PbO_2 deposit. Small amounts of manganese also are occasionally deposited with the PbO_2. Tin and manganese are rarely present in the PbO_2 in amounts which necessitate a purification of the deposit.

DETERMINATION OF LEAD AS SULFATE.

(FOR SAMPLES CONTAINING UP TO 0.2 PER CENT OF LEAD.)
(OPTIONAL.)

SOLUTIONS REQUIRED.

"*Lead Acid.*"—Mix 300 cc. of H_2SO_4, sp. gr. 1.84, and 1800 cc. of distilled water. Dissolve 1 g. of lead acetate, c. p., in 300 cc. of distilled water and add this to the hot solution, stirring meanwhile. Let stand at least 24 hours and syphon through a thick asbestos filter.

Dilute Alcohol for Washing.—Mix equal parts of denatured alcohol and distilled water.

METHOD.

In a 250-cc. beaker dissolve 5 g. of gun metal in 25 cc. of HNO_3, sp. gr. 1.42. Allow the solution to bake dry on the edge of a hot plate, or by standing over night on the steam bath. Add 17 cc. of HNO_3, sp. gr. 1.42, and after digesting for a short time, add 85 cc. of hot water and heat to boiling for a few

minutes. Allow the solution to stand for several hours at a temperature just below the boiling point. Filter off the precipitated H_2SnO_3 on double closely woven filter papers, being careful to keep the solution hot throughout the process of filtration. Wash with boiling hot water. To the combined filtrate and washings add 120 cc. of lead acid, and evaporate until copious fumes of H_2SO_4 are evolved. Cool, add 105 cc. of distilled water to dissolve the salts and to make the acid concentration the same as in lead acid, heat to boiling, and allow to cool and settle for 5 hours, or over night if convenient. Filter on a weighed porcelain Gooch crucible and wash with lead acid. Wash out the lead acid with dilute alcohol, set the Gooch crucible inside a porcelain crucible, dry and ignite for 5 minutes at the full heat of a Tirrill burner, cool and weigh as $PbSO_4$, which contains 68.29 per cent lead.

Accuracy.—Duplicate determinations should check within 0.01 per cent of lead. Results obtained by this method are likely to be about 0.01 per cent too low.

NOTE.

It is impossible to remove the tin quantitatively as H_2SnO_3 in the case of alloys containing over 0.25 per cent of iron, but by the preliminary baking and long standing, most of the H_2SnO_3 is precipitated.

DETERMINATION OF ZINC.

SOLUTIONS REQUIRED.

Dilute Hydrochloric Acid.—Mix 500 cc. of HCl, sp. gr. 1.20, and 500 cc. of distilled water.

METHOD.

See the "Determination of Copper by the Electrolytic Method."

After the copper has been completely deposited by electrolysis, quickly remove the cathode and wash it thoroughly in

distilled water, catching the washings in the beaker containing the electrolyte. Heat the solution and saturate with H_2S gas. Filter off any precipitate, and boil the solution to expel H_2S. Make the solution barely alkaline with NH_4OH, and add 25 cc. of 85-per-cent formic acid. Dilute the solution with distilled water to 300 cc., heat to boiling, and saturate with H_2S gas. Filter and wash with hot water. Dissolve the precipitate with hot dilute HCl, and transfer the solution to a weighed platinum or porcelain dish or crucible. Add a few drops of H_2SO_4, sp. gr. 1.84, and evaporate the solution until copious fumes escape. If the solution is not clear and colorless, cool, add a few cubic centimeters of HNO_3, sp. gr. 1.42, and again evaporate the solution until fumes of H_2SO_4 come off freely. Repeat the treatment with HNO_3 if necessary, until the organic matter is destroyed, and the solution is colorless. Remove the excess of H_2SO_4 by heating the dish cautiously, and finally heat to dull redness. Weigh as zinc sulfate, which contains 40.49 per cent of zinc.

Accuracy.—Duplicate determinations should check within 0.05 per cent of zinc.

DETERMINATION OF PHOSPHORUS BY THE ALKALIMETRIC METHOD.

Solutions Required.

Nitric Acid for Dissolving.—Mix 1000 cc. of HNO_3, sp. gr. 1.42, and 1200 cc. of distilled water.

Nitric Acid for Washing.—Mix 20 cc. of HNO_3, sp. gr. 1.42, and 1000 cc. of distilled water.

Ammonium Molybdate.

Solution No. 1.—Place in a beaker 100 g. of 85-per-cent molybdic acid, mix it thoroughly with 240 cc. of distilled water, add 140 cc. of NH_4OH, sp. gr. 0.90, filter and add 60 cc. of HNO_3, sp. gr. 1.42.

Solution No. 2.—Mix 400 cc. of HNO_3, sp. gr. 1.42, and 960 cc. of distilled water.

When the solutions are cold, add solution No. 1 to solution No. 2, stirring constantly; then add 0.1 g. of ammonium phosphate dissolved in 10 cc. of distilled water and let stand at least 24 hours before using.

Potassium Nitrate, 1-per-cent.—Dissolve 10 g. of KNO_3 in 1000 cc. of distilled water.

Phenolphthalein Indicator.—Dissolve 0.2 g. of phenolphthalein in 50 cc. of 95-per-cent ethyl alcohol and 50 cc. of distilled water.

Standard Sodium Hydroxide.—Dissolve 6.5 g. of purified NaOH in 1000 cc. of distilled water, add a slight excess of 1-per-cent solution of barium hydroxide, let stand for 24 hours, decant the liquid, and standardize it against a steel of known phosphorus content as determined by the molybdate-magnesia method, so that 1 cc. will be equivalent to 0.01 per cent of phosphorus on the basis of a 2-g. sample (see notes). Protect the solution from carbon dioxide with a soda-lime tube.

Ferric Chloride.—Dissolve 100 g. of ferric chloride (phosphorus free) in 100 cc. of distilled water.

Standard Nitric Acid.—Mix 10 cc. of HNO_3, sp. gr. 1.42, and 1000 cc. of distilled water. Titrate the solution against standardized NaOH, using phenolphthalein as indicator, and make it equivalent to the NaOH by adding distilled water.

METHOD.

In a 400-cc. casserole dissolve 1 g. of gun metal in 10 cc. of HNO_3, sp. gr. 1.42. Add 20 cc. of HCl, sp. gr. 1.20, and evaporate to dryness. Moisten with HCl, evaporate to dryness again, and bake to dull redness. Moisten with HCl again, add 3 cc. of ferric-chloride solution, and dilute to about 200 cc. with distilled water. Add NH_4OH, sp. gr. 0.90, until the basic salts of copper have dissolved and the solution has become a deep blue. Boil, allow to settle, and filter on a loosely woven filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitate on the filter with hot dilute HCl, dilute the solution to about 200 cc., add NH_4OH, sp. gr. 0.90,

until the precipitate which forms at first dissolves rather slowly, and saturate with H_2S gas. Filter off and reject the precipitate. Boil the filtrate to expel H_2S, and add HNO_3, sp. gr. 1.42, until the iron is oxidized. Add NH_4OH, sp. gr. 0.90, until the solution is alkaline. Boil and filter on a loosely woven filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitate on the filter with HNO_3 for dissolving, receiving the solution in a 350-cc. Erlenmeyer flask. Add NH_4OH, sp. gr. 0.90, until the iron is entirely precipitated, and then add HNO_3, sp. gr. 1.42, cautiously until the solution just becomes clear. Bring the solution to a temperature of about 80° C., and add 40 cc. of ammonium molybdate at room temperature. Allow to stand for one minute, shake or agitate for 3 minutes, and filter on a 9-cm. paper. Wash the precipitate three times with the 2-per-cent HNO_3 solution to free it from iron, and continue the washing with the 1-per-cent KNO_3 solution until the precipitate and flask are free from acid.

Transfer the paper and precipitate to a solution flask, add 20 cc. of distilled water, 5 drops of phenolphthalein solution as indicator, and an excess of standard NaOH solution. Insert a rubber stopper and shake vigorously until solution of the precipitate is complete. Wash off the stopper with distilled water and determine the excess of NaOH solution by titrating with standard HNO_3 solution. Each cubic centimeter of standard NaOH solution represents 0.01 per cent of phosphorus.

Accuracy.—Duplicate determinations should check within 0.01 per cent of phosphorus.

NOTES.

The ammonium-molybdate solution should be kept in a cool place and should always be filtered before using.

All distilled water used in titration should be freed from carbon dioxide by boiling or otherwise.

Bureau of Standards Standard Steel No. 19 (*a*) is recommended as a suitable steel for standardization of the NaOH solution.

DETERMINATION OF PHOSPHORUS BY THE FERRIC-ALUM METHOD.

(OPTIONAL.)

SOLUTIONS REQUIRED.

Ferric Chloride.—Dissolve 100 g. of ferric chloride (phosphorus free) in 100 cc. of distilled water.

Dilute Ammonia.—Mix 100 cc. of NH_4OH, sp. gr. 0.90, and 900 cc. of distilled water.

Dilute Hydrochloric Acid.—Mix 500 cc. of HCl, sp. gr. 1.20, and 500 cc. of distilled water.

Dilute Sulfuric Acid for Dissolving.—Mix 200 cc. of H_2SO_4, sp. gr. 1.84, and 800 cc. of distilled water.

Dilute Sulfuric Acid for Reductor.—Mix 50 cc. of H_2SO_4, sp. gr. 1.84, and 1000 cc. of distilled water. This solution is used boiling hot.

Ammonium Molybdate.

Solution No. 1.—Place in a beaker 100 g. of 85-per-cent molybdic acid, mix it thoroughly with 240 cc. of distilled water, add 140 cc. of NH_4OH, sp. gr. 0.90, filter and add 60 cc. of HNO_3, sp. gr. 1.42.

Solution No. 2.—Mix 400 cc. of HNO_3, sp. gr. 1.42, and 960 cc. of distilled water.

When the solutions are cold, add solution No. 1 to solution No. 2, stirring constantly, then add 0.1 g. of ammonium phosphate dissolved in 10 cc. of distilled water, and let stand at least 24 hours before using.

Acid Ammonium Sulfate.—Mix 25 cc. of H_2SO_4, sp. gr. 1.84, and 1000 cc. of distilled water, and then add 15 cc. of NH_4OH, sp. gr. 0.90.

Ferric Alum.—Dissolve 200 g. of ferric ammonium sulfate crystals in 1950 cc. of distilled water. Add 50 cc. of H_2SO_4, sp. gr. 1.84, and 80 cc. of phosphoric acid, 85 per cent.

Potassium Permanganate.—Dissolve from 3.0 to 3.2 g. of $KMnO_4$ in 1000 cc. of distilled water. Allow the solution to stand for about one week, and then filter it through an asbestos

filter. Standardize by using about 0.200-g. portions of pure sodium oxalate.

METHOD.

In a 400-cc. casserole dissolve 1 g. of gun metal in 10 cc. of HNO_3, sp. gr. 1.42. Add 20 cc. of HCl, sp. gr. 1.20, and evaporate to dryness. Moisten with HCl, evaporate to dryness again, and bake to dull redness. Moisten with HCl again, add 3 cc. of ferric chloride solution, and dilute to about 200 cc. with distilled water. Add NH_4OH, sp. gr. 0.90, until the basic salts of copper have dissolved and the solution has become a deep blue. Boil, allow to settle, and filter on a loosely woven filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitate on the filter with hot dilute HCl, dilute the solution to about 200 cc., add NH_4OH, sp. gr. 0.90, until the precipitate which forms at first dissolves rather slowly, and saturate with H_2S gas. Filter off and reject the precipitate. Boil the filtrate to expel H_2S, and add HNO_3, sp. gr. 1.42, until the iron is oxidized. Add NH_4OH, sp. gr. 0.90, until the solution is alkaline. Boil and filter on a loosely woven filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitate on the filter with hot dilute H_2SO_4, receiving the solution in a 350-cc. Erlenmeyer flask. Add NH_4OH, sp. gr. 0.90, until the iron is entirely precipitated, and then add HNO_3, sp. gr. 1.42, cautiously until the solution just becomes clear. Bring the solution to a temperature of about 80° C., and add 40 cc. of ammonium molybdate at room temperature. Allow to stand for one minute, shake or agitate for 3 minutes, filter on a 9-cm. paper, and wash very thoroughly (about 25 times) with acid ammonium sulfate. Dissolve the precipitate on the paper using 50 cc. of dilute ammonia. Add sufficient H_2SO_4 to adjust the acidity to 2.5 per cent by volume, and immediately pass the solution through a Jones reductor, which has the reductor tube prolonged and reaching nearly to the bottom of the flask, dipping into 50 cc. of ferric-alum solution. Wash through the reductor with 150 cc. of the H_2SO_4 for reductor and follow with 100 cc. of distilled water. Titrate with the standard $KMnO_4$ solution.

By this method the molybdenum which in passing through the reductor has been reduced entirely to the form corresponding to the oxide Mo_2O_3, is partially oxidized by the ferric alum, an equivalent amount of iron being reduced to the ferrous condition. The resultant solution is not rapidly oxidized through contact with air during the titration, and the calculations can therefore be made on the Mo_2O_3—$2MoO_3$ basis.

Accuracy.—Duplicate determinations should check within 0.01 per cent of phosphorus.

NOTES.

The ammonium-molybdate solution should be kept in a cool place and should always be filtered before using.

A blank determination should be made on corresponding amounts of acid and water, passing through the reductor into the usual amount of ferric-alum solution in the flask.

A small quantity of liquid should always be left in the reductor funnel, and air should never be allowed to enter the reductor.

For description and further details of the use of reductor see "Chemical Analysis of Iron" by A. A. Blair, or "Quantitative Chemical Analysis" by H. P. Talbot.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS AND TESTS FOR COMPRESSIVE STRENGTH OF PORTLAND-CEMENT MORTARS.[1]

Serial Designation: C 9 – 16 T.

These specifications and tests are issued under the fixed designation C 9; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916.

SPECIFICATIONS.

Compressive Strength. 1. The average compressive strength in pounds per square inch of not less than three standard mortar test pieces (see Section 4) composed of one part cement and three parts standard sand, by weight, shall be equal to or higher than the following:

Age at Test, days.	Storage of Test Pieces.	Compressive Strength, lb. per sq. in.
7	1 day in moist air, 6 days in water........................	1200
28	1 day in moist air, 27 days in water........................	2000

[1] Criticisms of these Tentative Specifications and Tests are solicited and should be directed, preferably before January 1, 1919, to Mr. P. H. Bates, Secretary of Committee C-1 on Cement, Bureau of Standards, Pittsburgh, Pa.

These specifications and tests, when adopted as standard, will be added to the present Standard Specifications and Tests for Portland Cement (C 9-17), 1918 Book of A.S.T.M. Standards.

Strength at 28 Days.

2. The average compressive strength of standard mortar at 28 days shall be higher than the strength at 7 days.

TESTS.

Mixing Standard Mortar.

3. The requirements governing the preparation of standard sand mortars for tension test pieces shall apply to compression test pieces.[1]

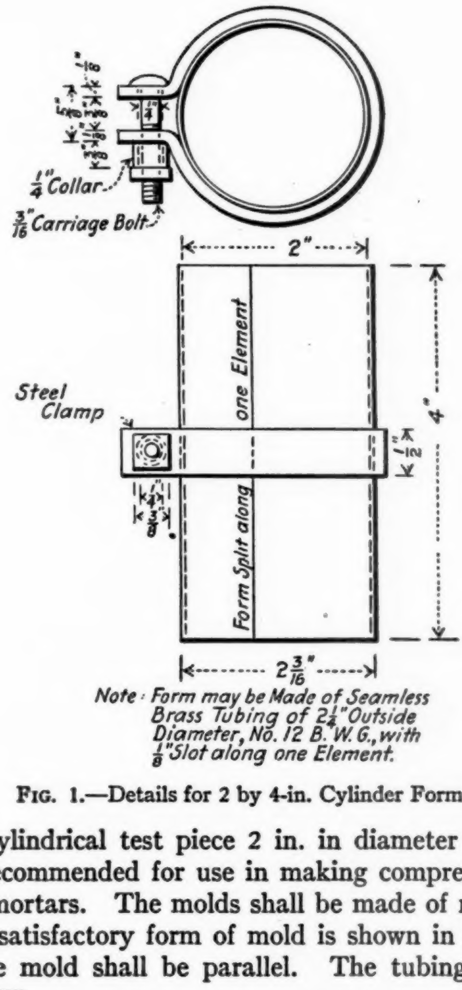

FIG. 1.—Details for 2 by 4-in. Cylinder Form.

Form of Test Piece.

4. A cylindrical test piece 2 in. in diameter and 4 in. in length is recommended for use in making compression tests of standards mortars. The molds shall be made of non-corroding metal. A satisfactory form of mold is shown in Fig. 1. The ends of the mold shall be parallel. The tubing used in the

[1] See Standard Specifications and Tests for Portland Cement (C 9-17), 1918 Book of A.S.T.M. Standards.

molds shall be of sufficient thickness to prevent appreciable distortion. The molds shall be oiled before using. During the molding of the test piece, the mold shall rest on a clean, plane surface (preferably a piece of plate glass which is allowed to remain in place until the mold is removed).

Molding. 5. The mortar[1] shall be placed in the mold in layers about 1 in. in thickness, each layer being tamped by means of the steel tamper shown in Fig. 2. The weight of tamper shall be approximately ¾ lb. In finishing the test piece, the mortar shall be heaped above the mold and smoothed off with a trowel. As soon as the test pieces from one sample are molded, the top of each test piece shall be covered with a piece of glass which is brought to a firm bearing on the fresh mortar. The cover glasses shall remain in place until the molds are removed.

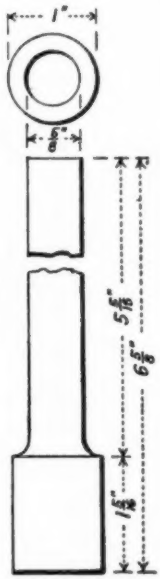

FIG. 2.—Details for Steel Tamper.

Storage. 6. The compression test pieces shall be stored in the same manner as the tension test pieces.

Testing. 7. Tests of standard-mortar cylinders shall be made in any testing machine which is adapted to meet the specified requirements. The test pieces shall be tested as soon as removed from the water. The ends of the test cylinders shall be smooth, plane surfaces. The metal bearing plates of the testing machine shall be placed in direct contact with the ends of the test piece. During the test a spherical bearing block shall be used on top of the cylinder. In order to secure a uniform distribution of the load over the test cylinder the spherical bearing block must be accurately centered. The diameter of the spherical bearing block should be only a little greater than that of the test piece. The test piece shall be loaded continuously to failure. The moving head of the testing machine shall travel at the rate of not less than 0.05 or more than 0.10 in. per minute.

[1] If sufficient mortar for six 2 by 4-in. cylinders is to be mixed in a single batch, approximately 3000 g. of material will be required. In this case the mixing shall be continued for 1½ minutes.

8. Testing machines should be frequently calibrated in order to determine their accuracy. **Calibration.**

9. Cylinders that are manifestly faulty, or which give strengths differing more than 15 per cent from the average value of all test pieces tested at the same period and made from the same sample, shall not be considered in determining the compressive strength. **Faulty Cylinders.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR CLAY SEWER PIPE.[1]

Serial Designation: C 13 - 18 T.

These specifications are issued under the fixed designation C 13; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

Material Covered. 1. These specifications cover clay products intended to be used for the conveyance of sewage, industrial wastes and storm water.

Single Class. 2. Sewer pipes furnished under these specifications shall be of a single class to be designated "A.S.T.M. Clay Sewer Pipe."

I. MATERIAL AND MANUFACTURE.

Materials. 3. (*a*) Clay pipes shall be manufactured from clay, fire clay or shale, or a combination of these materials.

(*b*) *Clay.*—Clay is intended to mean red burning plastic clay devoid of fissile fracture with maturing temperature about 1170° C. (2138° F.).

(*c*) *Fire Clay.*—Fire clay is intended to mean buff, gray or reddish burning fire clay showing conchoidal structure, with maturing temperature about 1250° C. (2282° F.).

(*d*) *Shale.*—Shale is intended to mean red burning hard clay with a distinct fissile fracture and vitrifying at from 1050 to 1250° C. (1922 to 2280° F.).

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[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Rudolph Hering, Chairman of Committee C-4 on Clay and Cement Sewer Pipe, 170 Broadway, New York City.

(*e*) The materials shall possess such physical and chemical properties that when molded into pipes and subjected to a suitable temperature the product will be strong, durable and serviceable, free from objectionable defects, and in compliance with these specifications and tests.

II. CHEMICAL TESTS AND REQUIREMENTS.

Chemical Tests and Requirements.

4. The consumer or purchaser may prescribe in advance special chemical requirements in cases where industrial wastes have marked acid or alkaline character, or are of abnormally high temperatures. He may make use of chemical analysis of the pipe material to ascertain whether these special requirements are met. The presence of visible grains or masses of caustic lime, iron pyrites or any other materials which cause slaking or disintegration shall be a cause for rejection.

III. PHYSICAL TESTS.

Physical Tests.

5. The physical tests of pipes shall include: crushing test, hydrostatic pressure test, and absorption test.[1]

Test Specimens.

6. The specimens to be tested shall be selected by the purchaser or his representative at the point or points designated by him when placing the order. The manufacturer or seller shall furnish specimens for test, without separate charge, up to 1 per cent of the number of pipes to be delivered or furnished in each size of pipe. The minimum number of specimens for any delivery less than 200 pieces shall be two specimens in each size of pipe.

Acceptance of Rejection on Result of Tests.

7. Failure of 20 per cent of the specimens to meet the requirements of any of the tests imposed, shall result in rejection of all the pipe in the shipment or delivery, corresponding to the sizes thus failing to comply; except that in the event of 20 per cent of the specimens in any size failing to meet the requirements, the manufacturer or seller may, with the consent of the consumer or purchaser, furnish for test additional specimens from the same shipment without charge. In case more than 80 per cent of the specimens tested, including those first tested, shall show substantial compliance for each of the various tests

[1] Committee C-4 will prepare a specification also for an abrasion test.

TABLE I.—DIMENSIONS, ETC., OF CLAY SEWER PIPE FURNISHED AS TEST SPECIMENS.

Specimen No.	Date.	Job No.	Material.	Manufacturer.	Location of Factory.	Nominal Size, in.	Weight, lb.	Length, ft.	Thickness of Spigot, in.				Thickness of Socket, in.				Internal Diameter, in.						Remarks.
																	Spigot.		Back of Socket.		Socket.		
									Invert.	Crown.	Side.	Side.	Invert.	Crown.	Side.	Side.	Vertical.	Hori-zontal.	Vertical.	Hori-zontal.	Vertical.	Hori-zontal.	

performed, then the entire shipment or delivery for this size shall be accepted; otherwise it shall be rejected.

8. The specimens of pipes shall be sound, full-size pipe. They shall first be freed from all visible moisture. When dry each specimen shall be weighed, measured and inspected. The results of these observations shall be recorded and preserved as shown in Table I. **Measurement and Observation of Specimens.**

9. Specimens which, when placed in a vertical position, do not give a metallic ring when struck with a hammer, or are observed to have fire cracks or other defects in form or dimensions in excess of the limits permitted in these specifications, shall be discarded and replaced with additional specimens from the shipment. **Rejection of Defective Specimens.**

(*A*) *Crushing Tests.*

10. (*a*) Any prime mover or hand power which will apply the load at a uniform rate of about 2000 lb. per minute, or in increments of not more than 100 lb. at the same rate, may be used in making the test. **Application of Load.**

(*b*) The pipe shall not be allowed to stand under load longer than is required to apply the load and to observe and record it.

(*c*) The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part.

(*d*) The bearings and the specimen shall be accurately centered so as to secure a symmetrical distribution of the loading on each side of the center of the pipe in every direction.

(*e*) The load shall be applied until the pipe yields by cracks passing through the shell.

11. (See Fig. 1, Plate VII.).—Except as otherwise hereinafter specified, the pipe to be tested shall be supported by a metallic knife bearing 1 in. wide and extended from a point just back of the socket to the spigot end of the pipe. Before the pipe is placed a fillet of plaster of Paris and sand 1 in. wide, and thick enough to compensate for all the inequalities of the pipe barrel, shall be cast on the surface of the knife-edge bearing. The pipe shall be placed upon the fillet while the plaster of Paris is still somewhat plastic. The load shall be applied through an upper knife bearing of the same size and length as the lower bearing. **Knife or Two-Edge Bearings.**

A plaster-of-Paris filet 1 in. wide shall be cast along the length of the crown of the pipe to equalize the lower bearing before the upper one is brought into contact.

Both of the bearings shall be sufficiently rigid to transmit and receive uniform loads throughout their lengths without deflection, and shall be so attached to the machine as to transmit and receive the maximum stresses produced by the tests without lost motion, vibration or sudden shock.

At the option of the consumer or purchaser the crushing test may be applied with sand bearings or with two or three-edge bearings.

The crushing strength shall be calculated by dividing the total load required to break each pipe by the net inside length of the barrel of the pipe, measuring from the bottom of the socket to the end of the spigot; and by then multiplying the quotient by the following factors:

For knife or two-edge bearings	$\frac{10}{7}$
" three-edge bearings	$\frac{10}{7}$
" sand bearings	1.00

Three-Edge Bearings. 12. (See Fig. 2, Plate VII.).—When three-edge bearings are used, the ends of each specimen of pipe shall be accurately marked in halves of the circumference prior to the test.

The two lower bearings shall consist of two wooden strips with vertical sides, each strip having its interior top corner rounded to a radius of approximately $\frac{1}{2}$ in. They shall be straight, and shall be securely fastened to a rigid block with their interior vertical sides 1 in. apart.

The upper bearing shall be a wooden block, straight and true from end to end.

The test load shall be applied through the upper bearing block in such a way as to leave the bearing free to move in a vertical plane passing midway between the lower bearings.

In testing a pipe which is "out of straight," the lines of the bearings chosen shall be from those which appear to give most favorable conditions for fair bearings.

Sand Bearings. 13. (See Fig. 3, Plate VII.).—When sand bearings are used, the ends of each specimen of pipe shall be accurately marked prior to the test in quarters of the circumference. Specimens

TENTATIVE SPECIFICATIONS FOR SEWER PIPE.

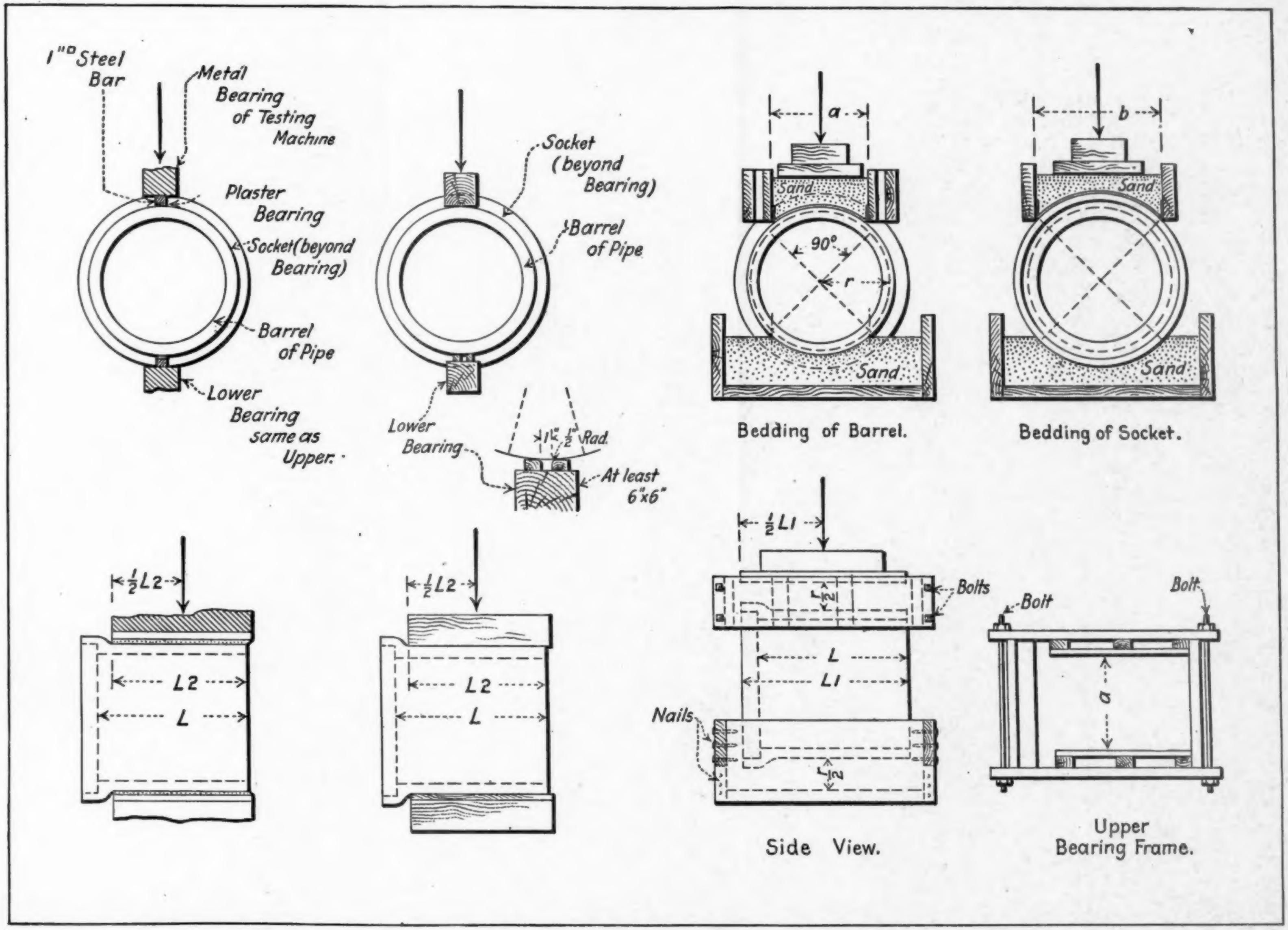

FIG 1.—Knife or Two-Edge Bearings.

FIG. 2.—Three-Edge Bearings.

FIG. 3.—Sand Bearings.

shall be carefully bedded, above and below, in sand, for one-fourth the circumference of the pipe measured on the middle line of the barrel. The depth of bedding above and below the pipe at the thinnest points shall be one-half the radius of the middle line of the barrel.

The sand used shall be clean, and shall be such as will pass a No. 4 screen.

The top bearing frame shall not be allowed to come in contact with the pipe nor with the top bearing plate. The upper surface of the sand in the top bearing shall be struck level with a straight edge, and shall be covered with a rigid top bearing plate, with lower surface a true plane, made of heavy timbers or other rigid material, capable of distributing the test load uniformly without appreciable bending. The test load shall be applied at the exact center of this top bearing plate, in such a manner as to permit free motion of the plate in all directions. For this purpose a spherical bearing is preferred, but two rollers at right angles may be used. The test may be made without the use of a testing machine, by piling weights directly on a platform resting on the top bearing plate, provided, however, that the weights shall be piled symmetrically about a vertical line through the center of the pipe, and that the platform shall not be allowed to touch the top bearing frame.

The frames of the top and bottom bearings shall be made of timbers so heavy as to avoid appreciable bending by the side pressure of sand. The interior surfaces of the frames shall be dressed. No frame shall come in contact with the pipe during the test. A strip of cloth may, if desired, be attached to the inside of the upper frame on each side, along the lower edge, to prevent the escape of sand between the frame and the pipe.

Number of Specimens.

14. The crushing test shall ordinarily be applied to not less than 75 per cent of the specimens received for testing purposes.

Specimens for Absorption Test.

15. Pieces of the crushed pipe may be used as specimens in making the absorption test.

(*B*) *Hydrostatic Test.*

Hydrostatic Test.

16. Sound full-size pipe not exceeding about 25 per cent of the specimens received for test in each size of pipe, shall be tested for leakage under internal hydrostatic pressure.

The ends of the pipe shall be tightly closed by wooden or metallic bulkheads or covers faced with rubber or leather so that no leakage shall occur through the covers at the test pressure. One cover shall be provided with a ¾-in. wrought-iron nipple passing through the cover, and held securely in place and made water-tight by means of locknuts and washers or gaskets. The outer end of the nipple shall be connected with a pump discharge or water service line.

Water pressure of 5 lb. per sq. in., as measured by a standardized gage attached to the delivery pipe close to the specimen, shall be internally applied to the specimen for 5 minutes. At the end of this period the water pressure shall be raised to 15 lb. per sq. in. and maintained for a period of 15 minutes.

The quantity of water passing through the barrel of the specimen at 15 lb. per sq. in. shall be collected and measured at the end of the test. The result shall be reported as percolation in gallons per mile in 24 hours.

(*C*) *Absorption Test.*

Test Specimens. 17. The specimens shall be sound pieces, with all edges broken, and may be from pipes broken in the crushing or other tests. They shall be from 12 to 20 sq. in. in area, and shall be as nearly square as they can be readily prepared. They shall be free from observable cracks, fissures, laminations or shattered edges.

Drying. 18. Preparatory to the absorption test, the specimen shall be first weighed and then dried in a drier or oven at a temperature of not less than 110° C. (230° F.) for not less than three hours. After removal from the drier, the specimen shall be allowed to cool in dry air to a temperature of 20 to 25° C. (68 to 77° F.), and then reweighed.

If the specimen is comparatively dry when taken, and the second weight closely agrees with the first, it shall be considered dry. If the specimen is wet when taken it shall be placed in the drier for a drying treatment of two hours and reweighed. If the third weight checks the second the specimen shall be considered dry. In case of any doubt, the specimen shall be redried for two-hour periods, until check weights are obtained.

19. The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall be read to the nearest gram. When other than metric weights are used, the same degree of accuracy shall be obtained. **Weighing.**

20. The specimen, after final drying, cooling and weighing, shall be placed with other similar specimens in a suitable wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rainwater, raised to the boiling point and boiled for five hours, and then cooled in water to a final temperature of 10 to 15° C. (50 to 59° F.). **Immersion.**

21. The specimen shall be allowed to drain for one minute, and, the superficial moisture having been removed by towel or blotting paper, placed upon the balance. **Reweighing.**

22. The test result shall be calculated as percentage of the initial dry weight. **Calculation of Absorption.**

23. One specimen shall be tested of each pipe broken in the crushing test. **Number of Specimens.**

24. The results shall be reported separately for each individual specimen, together with the mean for all the specimens from the same shipment of pipe. **Reporting Results.**

25. Each specimen shall be marked so that it may be identified with the pipe used in the crushing test from which the specimen was taken. The marking shall be applied so that the pigment used shall not cover more than 1 per cent of the total superficial area of the specimen. **Identification.**

IV. PHYSICAL TEST REQUIREMENTS.

26. The test requirements of clay sewer pipe shall be as given in Table II. The individual results of the various tests for each size of pipe and for each shipment class and mill shall be tabulated separately so as to show the percentage which fails to comply with the requirements of each test. **Physical Requirements**

V. A.S.T.M. SIZES AND DIMENSIONS.

27. Pipes shall be furnished of the sizes, internal diameter, and with the minimum dimensions given in Table III. Where several lengths are mentioned in the table the consumer or purchaser shall indicate, at the time of purchase, which lengths hall be furnished; and unless so indicated, the manufacturer hall furnish such lengths as he may elect. **Sizes and Dimensions.**

Permissible Variations. 28. The permissible variation from the dimensions given in Table III shall not exceed those stated in Table IV. Where the thickness of barrel is increased beyond that given in Table IV in order to meet the specified requirements of strength, the diameter at inside of socket shall be increased by double the increase in thickness of barrel. Pipes intended to be straight shall not have variation in alignment of more than $\frac{1}{8}$ in. per foot of length.

TABLE II.—PHYSICAL TEST REQUIREMENTS OF CLAY SEWER PIPE.

Internal Diameter, in.	Minimum Crushing Strength,[1] lb. per lin. ft.	Maximum Percolation, gal. per mile in 24 hr.	Maximum Absorption, per cent.
6	1430	These requirements will be furnished later.	These requirements will be furnished later.
8	1430		
10	1570		
12	1710		
15	1960		
18	2200		
21	2590		
24	3070		
27	3370		
30	3690		
33	3930		
36	4400		
39	4710		
42	5030		

[1] See end of Section 11.

VI. WORKMANSHIP AND FINISH.

Absence of Defects. 29. Pipes shall be substantially free from fractures, large or deep cracks and blisters, laminations and surface roughness.

Scored Ends. 30. The inner surface of the socket and the outer surface of the spigot end shall be scored by triangular shaped or semi-circular shaped rings about $\frac{1}{8}$ in. deep.

The number of scorings shall be as follows:

For pipes 6 to 10 in. in diameter, inclusive	2
" " 12 " 21 " " " "	3
" " 24 " 30 " " " "	4
" " 33 " 42 " " " "	5

31. The glaze shall consist of a continuous layer of bright or semi-bright glass substantially free from coarse blisters and pimples. If present none of these shall project more than ⅛ in. above the surrounding surface. Not more than 10 per cent of the inner surface of any pipe barrel shall be bare of glaze except the socket, where it may be entirely absent. Glazing will not be required on the outer surface of the barrel at the spigot end for a distance from the end equal to two-thirds the specified depth **Salt Glaze.**

TABLE III.—DIMENSIONS OF CLAY SEWER PIPE.

Internal Diameter, in.	Laying Length, ft.	Diameter at Inside of Socket, in.[1]	Depth of Socket, in.	Taper of Socket.	Minimum Thickness of Barrel, in.
6	2	8¼	2	1 : 20	⅝
8	2, 2½, 3	10¾	2¼	1 : 20	¾
10	2, 2½, 3	13	2½	1 : 20	⅞
12	2, 2½, 3	15¼	2½	1 : 20	1
15	2, 2½, 3	18¾	2½	1 : 20	1¼
18	2, 2½, 3	22¼	3	1 : 20	1½
21	2, 2½, 3	26	3	1 : 20	1¾
24	2, 2½, 3	29½	3	1 : 20	2
27	3	33¼	3½	1 : 20	2¼
30	3	37	3½	1 : 20	2½
33	3	40¼	4	1 : 20	2⅝
36	3	44	4	1 : 20	2¾
39	3	47¼	4	1 : 20	2⅞
42	3	51	4	1 : 20	3

[1] When pipes are furnished having an increase in thickness over that given in last column, then the diameter of socket shall be increased by an amount equal to twice the increase of thickness of barrel.

of socket for the corresponding size of pipe. Where glazing is required there shall be absence of any well-defined net work of crazing lines or hair cracks. All glazing shall be equal to that produced by the best salt-glazing process.

32. The ends of the pipes shall be square with their longitudinal axis, except as provided in Table IV. **Finish of Ends.**

33. (*a*) Special shapes shall have a plain spigot end and a socket end corresponding in all respects with the dimensions specified for pipes of the corresponding internal diameter. Branch pipes shall be furnished to lay the same lengths as straight pipe. **Specials.**

All specials shall conform in finish to the specifications for pipes given in Sections 29, 30, 31 and 32.

(*b*) Slants shall have their spigot ends cut at an angle of approximately 45 deg. with the longitudinal axis.

(*c*) Curves shall be at angles of 90, 45, $22\frac{1}{2}$ deg., as required. They shall conform substantially to the curvature specified.

(*d*) Branches shall be furnished with the connection or con-

TABLE IV.—PERMISSIBLE VARIATIONS IN DIMENSIONS OF CLAY SEWER PIPE.

Normal Size in.	Limits of Permissible Variation in:					
	Length, in. per ft. (−)	Lengths of Two Opposite Sides, in.	Internal Diameter, in.		Depth of Socket, in. (−)	Thickness of Barrel, in. (−)
			Spigot (±)	Socket (±)		
6	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$
8	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{16}$
10	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{16}$
12	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{16}$
15	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{32}$
18	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{4}$	$\frac{3}{32}$
21	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$
24	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
27	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
30	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
33	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{1}{4}$	$\frac{3}{16}$
36	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{1}{4}$	$\frac{3}{16}$
39	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{1}{4}$	$\frac{3}{16}$
42	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{1}{4}$	$\frac{3}{16}$

NOTE.—The minus sign (−) alone indicates that the plus variation is not limited; the plus and minus sign (±) indicates variation in both excess and deficiency in dimension.

nections of the size or sizes specified, securely and completely fastened by fusion in the process of vitrification to the barrel of the pipe. T-branches and double T-branches shall have the axis perpendicular to the longitudinal axis of the pipe. Y-branches, double Y-branches, and V-branches shall have their axes approximately 45 deg. from the longitudinal axis of the pipe measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length

to permit making a proper joint when the connecting pipe is inserted in the branch socket.

(*e*) Channel or split pipes, curves and branches shall be accurate half sections of the corresponding size of straight pipe and specials.

VII. MARKINGS.

34. Pipes shall bear the initials or name of the person, company or corporation by whom they are manufactured, and the location of the mill. The markings shall be indented on the exterior of the barrel near the socket and shall be plainly legible for purpose of identification. **Markings.**

VIII. INSPECTION.

35. All pipes shall be subject to inspection at the factory, trench or other point of delivery by a competent inspector employed by the consumer or purchaser. The purposes of the inspection shall be to cull and reject pipes which, independent of the physical tests herein specified, fail to comply with the requirements of these specifications. **Inspection.**

36. Pipes shall be subject to rejection on account of the following: **Rejection.**

(*a*) Variations in any dimension exceeding the permissible variations given in Table IV.

(*b*) Fracture or cracks passing through the shell or socket, except that a single crack at either end of a pipe not exceeding 2 in. in length or a single fracture in the socket not exceeding 3 in. in width nor 2 in. in length will not be deemed cause for rejection unless these defects exist in more than 5 per cent of the entire shipment or delivery.

(*c*) Blisters where the glazing is broken or which exceed 3 in. in diameter, or which project more than $\frac{1}{8}$ in. above the surface.

(*d*) Laminations which indicate extended voids in the pipe material.

(*e*) Fire cracks or hair cracks sufficient to impair the strength, durability or serviceability of the pipe.

(*f*) Variation of more than $\frac{1}{8}$ in. per linear foot in alignment of a pipe intended to be straight.

(*g*) Glaze which does not fully cover and protect all parts of the shell and ends except those exempted in Section 31; also glaze which is not equal to best salt glaze.

(*h*) Failure to give a clear ringing sound when placed on end and dry-tapped with a light hammer.

(*i*) Insecure attachment of branches on spurs.

Marking of Rejected Specimens. 37. All rejected pipes shall be plainly marked by the inspector and shall be replaced by the manufacturer or seller with pipes which meet the requirements of these specifications, without additional cost to the consumer or purchaser.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR CEMENT-CONCRETE SEWER PIPE.[1]

Serial Designation: C 14 – 18 T.

These specifications are issued under the fixed designation C 14; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

Material Covered. 1. These specifications cover cement-concrete products intended to be used for the conveyance of sewage, industrial wastes and storm water.

Single Class. 2. Pipes furnished under these specifications shall be of a single class to be designated "A.S.T.M. Cement-Concrete Sewer Pipe."

I. MATERIAL AND MANUFACTURE.

Materials. 3. (*a*) Cement-concrete pipes shall be manufactured from Portland-cement concrete.

(*b*) *Concrete.*—By concrete is meant a suitable mixture of Portland cement, mineral aggregates and water, hardened by hydraulic chemical action.

(*c*) *Cement.*—Portland cement shall meet the requirements

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Rudolph Hering, Chairman of Committee C-4 on Clay and Cement Sewer Pipe, 170 Broadway, New York City.

of the Standard Specifications and Tests for Portland Cement (Serial Designation: C 9)[1] of the American Society for Testing Materials.

(*d*) The materials shall possess such physical and chemical properties that when molded into pipes and properly cured the product will be strong, durable and serviceable, free from objectionable defects, and in compliance with these specifications and tests.

II. CHEMICAL TESTS AND REQUIREMENTS.

Chemical Tests and Requirements.

4. The consumer or purchaser may prescribe in advance special chemical requirements in cases where sewage, industrial wastes or ground waters have marked acid or alkaline character, or are of abnormally high temperatures. He may make use of chemical analysis of the pipe materials to ascertain whether these special requirements are met. The presence of deleterious materials causing slaking or disintegration shall be cause for rejection.

III. PHYSICAL TESTS.

Physical Tests.

5. The physical tests of pipes shall include: crushing test, hydrostatic pressure test and absorption test.[2]

Test Specimens.

6. The specimens to be tested shall be selected by the purchaser or his representative at the point or points designated by him when placing the order. The manufacturer or seller shall furnish specimens for test, without separate charge, up to 1 per cent of the number of pipes to be delivered or furnished in each size of pipe. The minimum number of specimens for any delivery less than 200 pieces shall be two specimens of each size of pipe.

Acceptance or Rejection on Result of Tests.

7. Failure of 20 per cent of the specimens to meet the requirements of any of the tests imposed, shall result in rejection of all the pipe in the shipment or delivery, corresponding to the sizes thus failing to comply; except that in the event of 20 per cent of the specimens in any size failing to meet the requirements, the manufacturer or seller may, with the consent of the consumer or purchaser, furnish for test additional specimens from the same shipment without charge. In case more than 80 per cent of the specimens tested, including those first tested,

[1] 1918 Book of A.S.T.M. Standards.

[2] Committee C-4 will prepare a specification also for an abrasion test.

TABLE I.—DIMENSIONS, ETC., OF CEMENT-CONCRETE SEWER PIPE FURNISHED AS TEST SPECIMENS.

Specimen No.	Date.	Job No.	Material.	Manufacturer.	Location of Factory.	Nominal Size, in.	Weight, lb.	Length, ft.	Thickness of Spigot, in.				Thickness of Socket, in.				Internal Diameter, in.						Remarks.
																	Spigot.		Back of Socket.		Socket.		
									Invert.	Crown.	Side.	Side.	Invert.	Crown.	Side.	Side.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	

shall show substantial compliance for each of the various tests performed, then the entire shipment or delivery for this size shall be accepted; otherwise it shall be rejected.

Measurement and Observation of Specimens. 8. The specimens of pipes shall be sound, full-size pipe. They shall first be freed from all visible moisture. When dry each specimen shall be weighed, measured and inspected. The results of these observations shall be recorded and preserved as shown in Table I.

Rejection of Defective Specimens. 9. Specimens which, when placed in a vertical position, do not give a metallic ring when struck with a hammer, or are observed to have cracks or other defects in form or dimensions in excess of the limits permitted in these specifications, shall be discarded and replaced with additional specimens from the shipment.

(*A*) *Crushing Test.*

Application of Load. 10. (*a*) Any prime mover or hand power which will apply the load at a uniform rate of about 2000 lb. per minute, or in increments of not more than 100 lb. at the same rate, may be used in making the test.

(*b*) The pipe shall not be allowed to stand under load longer than is required to apply the load and to observe and record it.

(*c*) The testing machine shall be substantial and rigid throughout, so that the distribution of the load will not be affected appreciably by the deformation or yielding of any part.

(*d*) The bearings and the specimen shall be accurately centered so as to secure a symmetrical distribution of the loading on each side of the center of the pipe in every direction.

(*e*) The load shall be applied until the pipe yields by cracks passing through the shell.

Knife or Two-Edge Bearings. 11. (See Fig. 1, Plate VII.)[1].—Except as otherwise hereinafter specified, the pipe to be tested shall be supported by a metallic knife bearing 1 in. wide and extended from a point just back of the socket to the spigot end of the pipe. Before the pipe is placed a fillet of plaster of Paris and sand 1 in. wide, and thick enough to compensate for all the inequalities of the pipe barrel, shall be cast on the surface of the knife bearing. The pipe shall be placed upon the fillet while the plaster of Paris is still somewhat plastic. The load shall be applied

[1] See p. 546.

through an upper knife bearing of the same size and length as the lower bearing. A plaster-of-Paris fillet 1 in. wide shall be cast along the length of the crown of the pipe to equalize the lower bearing before the upper one is brought into contact.

Both of the bearings shall be sufficiently rigid to transmit and receive uniform loads throughout their lengths without deflection, and shall be so attached to the machine as to transmit and receive the maximum stresses produced by the tests without lost motion, vibration or sudden shock.

At the option of the consumer or purchaser the crushing test may be applied with sand bearings or with two or three-edge bearings.

The crushing strength shall be calculated by dividing the total load required to break each pipe by the net inside length of the barrel of the pipe, measuring from the bottom of the socket to the end of the spigot; and by then multiplying the quotient by the following factors:

For knife or two-edge bearings	$\frac{10}{7}$
" three-edge bearings	$\frac{10}{7}$
" sand bearings	1.00

Three-Edge Bearings.

12. (See Fig 2, Plate VII.)[1]—When three-edge bearings are used, the ends of each specimen of pipe shall be accurately marked in halves of the circumference prior to the test.

The two lower bearings shall consist of two wooden strips with vertical sides, each strip having its interior top corner rounded to a radius of approximately $\frac{1}{2}$ in. They shall be straight, and shall be securely fastened to a rigid block with their interior vertical sides 1 in. apart.

The upper bearing shall be a wooden block, straight and true from end to end.

The test load shall be applied through the upper bearing block in such a way as to leave the bearing free to move in a vertical plane passing midway between the lower bearings.

In testing a pipe which is "out of sight," the lines of the bearings chosen shall be from those which appear to give most favorable conditions for fair bearings.

Sand Bearings.

13. (See Fig. 3, Plate VII.)[1]—When sand bearings are used, the ends of each specimen of pipe shall be accurately marked

[1] See p. 545.

prior to the test in quarters of the circumference. Specimens shall be carefully bedded, above and below, in sand, for one-fourth the circumference of the pipe measured on the middle line of the barrel. The depth of bedding above and below the pipe at the thinnest points shall be one-half the radius of the middle line of the barrel.

The sand used shall be clean, and shall be such as will pass a No. 4 screen.

The top bearing frame shall not be allowed to come in contact with the pipe nor with the top bearing plate. The upper surface of the sand in the top bearing shall be struck level with a straight edge, and shall be covered with a rigid top bearing plate, with lower surface a true plane, made of heavy timbers or other rigid material, capable of distributing the test load uniformly without appreciable bending. The test load shall be applied at the exact center of this top bearing plate, in such a manner as to permit free motion of the plate in all directions. For this purpose a spherical bearing is preferred, but two rollers at right angles may be used. The test may be made without the use of a testing machine, by piling weights directly on a platform resting on the top bearing plate, provided, however, that the weights shall be piled symmetrically about a vertical line through the center of the pipe, and that the platform shall not be allowed to touch the top bearing frame.

The frames of the top and bottom bearings shall be made of timbers so heavy as to avoid appreciable bending by the side pressure of sand. The interior surfaces of the frames shall be dressed. No frame shall come in contact with the pipe during the test. A strip of cloth may, if desired, be attached to the inside of the upper frame on each side, along the lower edge, to prevent the escape of sand between the frame and the pipe.

Number of Specimens. 14. The crushing test shall ordinarily be applied to not less than 75 per cent of the specimens received for testing purposes.

Specimens for Absorption Test. 15. Pieces of the crushed pipe may be used as specimens in making the absorption test.

(*B*) *Hydrostatic Test.*

Hydrostatic Test. 16. Sound full-size pipe not exceeding about 25 per cent of the specimens received for test in each size of pipe, shall be tested for leakage under internal hydrostatic pressure.

The ends of the pipe shall be tightly closed by wooden or metallic bulkheads or covers faced with rubber or leather so that no leakage shall occur through the covers at the test pressure. One cover shall be provided with a $\frac{3}{4}$-in. wrought-iron nipple passing through the cover, and held securely in place and made water-tight by means of locknuts and washers or gaskets. The outer end of the nipple shall be connected with a pump discharge or water service line.

Water pressure of 5 lb. per sq. in., as measured by a standardized gage attached to the delivery pipe close to the specimen, shall be internally applied to the specimen for 5 minutes. At the end of this period the water pressure shall be raised to 15 lb. per sq. in. and maintained for a period of 15 minutes.

The quantity of water passing through the barrel of the specimen at 15 lb. per sq. in. shall be collected and measured at the end of the test. The result shall be reported as percolation in gallons per mile in 24 hours.

(*C*) *Absorption Test.*

17. The specimens shall be sound pieces with all edges broken, and may be from pipes broken in the crushing or other tests. They shall be from 12 to 20 sq. in. in area, and shall be as nearly square as they can be readily prepared. They shall be free from observable cracks, fissures, laminations or shattered edges. **Test Specimens.**

18. Preparatory to the absorption test, the specimen shall be first weighed and then dried in a drier or oven at a temperature of not less than 110° C. (230° F.) for not less than three hours. After removal from the drier, the specimen shall be allowed to cool in dry air to a temperature of 20 to 25° C. (68 to 77° F.), and then reweighed. **Drying.**

If the specimen is comparatively dry when taken, and the second weight closely agrees with the first, it shall be considered dry. If the specimen is wet when taken it shall be placed in the drier for a drying treatment of two hours and reweighed. If the third weight checks the second the specimen shall be considered dry. In case of any doubt, the specimen shall be redried for two-hour periods, until check weights are obtained.

19. The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall be read to the nearest gram. **Weighing.**

When other than metric weights are used, the same degree of accuracy shall be obtained.

Immersion. 20. The specimen, after final drying, cooling and weighing shall be placed with other similar specimens in a suitable wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rainwater, raised to the boiling point and boiled for five hours, and then cooled in water to a final temperature of 10 to 15° C. (50 to 59° F.).

Reweighing. 21. The specimen shall be allowed to drain for one minute, and, the superficial moisture having been removed by towel or blotting paper, placed upon the balance.

Calculation of Absorption. 22. The test result shall be calculated as percentage of the initial dry weight.

Number of Specimens. 23. One specimen shall be tested of each pipe broken in the crushing test.

Reporting Results. 24. The results shall be reported separately for each individual specimen together with the mean for all the specimens from the same shipment of pipe.

Identification. 25. Each specimen shall be marked so that it may be identified with the pipe used in the crushing test from which the specimen was taken. The marking shall be applied so that the pigment used shall not cover more than 1 per cent of the total superficial area of the specimen.

IV. PHYSICAL TEST REQUIREMENTS.

Physical Test Requirements. 26. The test requirements of cement-concrete pipe shall be as given in Table II. The individual results of the various tests for each size of pipe and for each shipment class and mill shall be tabulated separately so as to show the percentage which fails to comply with the requirements of each test.

V. A.S.T.M. SIZES AND DIMENSIONS.

Sizes and Dimensions. 27. Pipes shall be furnished of the sizes, internal diameter, and with the minimum dimensions given in Table III. Where several lengths are mentioned in the table the consumer or purchaser shall indicate, at the time of purchase, which lengths shall be furnished; and unless so indicated, the manufacturer shall furnish such lengths as he may elect.

28. The permissible variation from the dimensions given in Table III shall not exceed those stated in Table IV. Where the thickness of barrel is increased beyond that given in Table III in order to meet the specified requirements of strength, the diameter at inside of socket shall be increased by double the increase in thickness of barrel. Pipes intended to be straight shall not have variation in alignment of more than $\frac{1}{8}$ in. per foot of length. **Permissible Variations.**

TABLE II.—PHYSICAL TEST REQUIREMENTS OF CEMENT-CONCRETE SEWER PIPE.

Internal Diamter, in.	Minimum Crushing Strength, lb. per lin. ft.	Maximum Percolation, gal. per mile in 24 hr.	Maximum Absorption, per cent.
6	1430	These requirements will be furnished later.	These requirements will be furnished later.
8	1430		
10	1570		
12	1710		
15	1960		
18	2200		
21	2590		
24	3070		
27	3370		
30	3690		
33	3930		
36	4400		
39	4710		
42	5030		

VI. WORKMANSHIP AND FINISH.

29. Pipes shall be substantially free from fractures, large or deep cracks and blisters, laminations and surface roughness. **Absence of Defects.**

30. The ends of the pipes shall be square with their longitudinal axis. **Finish of Ends.**

31. (*a*) Special shapes shall have a plain spigot end and a socket end corresponding in all respects with the dimensions specified for pipes of the corresponding internal diameter. Branches shall be furnished to lay the same lengths as straight **Specials.**

pipe. All specials shall conform in finish to the specifications for pipes given in Sections 29 and 30.

(*b*) Slants shall have their spigot ends cut at an angle of approximately 45 deg. with the longitudinal axis.

(*c*) Curves shall be at angles of 90, 45, 22½ deg., as required. They shall conform substantially to the curvature specified.

(*d*) Branches shall be furnished with the connection or connections of the size or sizes specified, securely and completely

TABLE III.—DIMENSIONS OF CEMENT-CONCRETE SEWER PIPE.

Interna Diameter, in.	Laying Length, ft.	Diameter at Inside of Socket, in.[1]	Normal Annular Space, in.	Depth of Socket, in.	Taper of Socket.	Minimum Thickness of Barrel, in.
6	2	8¼	½	2	1 : 20	⅝
8	2, 2½, 3	11	⅝	2¼	1 : 20	¾
10	2, 2½, 3	13¼	⅝	2½	1 : 20	⅞
12	2, 2½, 3	15⅝	⅝	2½	1 : 20	1
15	2, 2½, 3	19¼	⅝	2½	1 : 20	1¼
18	2, 2½, 3	22¾	⅝	2¾	1 : 20	1½
21	2, 2½, 3	26½	¾	2¾	1 : 20	1¾
24	2, 2½, 3	30¼	¾	3	1 : 20	2⅛
27	3	34	⅞	3¼	1 : 20	2¼
30	3	38	1	3½	1 : 20	2½
33	3	41½	1	4	1 : 20	2¾
36	3	45½	1¼	4	1 : 20	3
39	3	49	1¼	4	1 : 20	3¼
42	3	53	1½	4	1 : 20	3½

[1] When pipes are furnished having an increase in thickness over that given in last column, then the diameter of socket shall be increased by an amount equal to twice the increase of thickness of barrel.

fastened in the process of manufacture to the barrel of the pipe. T-branches and double T-branches shall have the axis perpendicular to the longitudinal axis of the pipe. Y-branches, double Y-branches, and V-branches shall have their axes approximately 45 deg. from the longitudinal axis of the pipe measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.

(*e*) Channel or split pipe, curves and branches shall be accurate half sections of the corresponding size of pipe or other specials.

VII. MARKINGS.

32. Pipes shall bear the initials or name of the person, company or corporation by whom they are manufactured, and **Markings.**

TABLE IV.—PERMISSIBLE VARIATIONS IN DIMENSIONS OF CEMENT-CONCRETE SEWER PIPE.

Normal Size, in.	Limits of Permissible Variation in: Length, in. per ft. (−)	Internal Diameter, in. Spigot (±)	Internal Diameter, in. Socket (±)	Depth of Socket, in. (−	Thickness of Barrel, in. (−)
6	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{16}$
8	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$
10	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$
12	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$
15	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{32}$
18	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{32}$
21	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
24	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
27	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{8}$
30	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{8}$
33	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{16}$
36	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{16}$
39	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{16}$
42	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{16}$

NOTE.—The minus sign (−) alone indicates that the plus variation is not limited; the plus and minus sign (±) indicates variation in both excess and deficiency in dimension.

the location of the mill. The markings shall be indented or stenciled on the exterior or interior of the barrel near the socket and shall be plainly legible for purpose of identification.

VIII. INSPECTION.

33. All pipes shall be subject to inspection at the factory, trench or other point of delivery by a competent inspector employed by the consumer or purchaser. The purposes of **Inspection.**

the inspection shall be to cull and reject pipes which, independent of the physical tests herein specified, fail to meet the requirements of these specifications.

Rejection.

34. Pipes shall be subject to rejection on account of the following:

(*a*) Variations in any dimension exceeding the permissible variations given in Table IV.

(*b*) Fracture or cracks passing through the shell or socket, except that a single crack at either end of a pipe not exceeding 2 in. in length or a single fracture in the socket not exceeding 3 in. in width nor 2 in. in length will not be deemed cause for rejection unless these defects exist in more than 5 per cent of the entire shipment or delivery.

(*c*) Blisters where the surface is broken or which project more than $\frac{1}{8}$ in. above the surface.

(*d*) Defects which indicate imperfect mixing and molding.

(*e*) Cracks sufficient to impair the strength, durability or serviceability of the pipe.

(*f*) Variation of more than $\frac{1}{8}$ in. per linear foot in alignment of a pipe intended to be straight.

(*g*) Failure to give a clear ringing sound when placed on end and dry-tapped with a light hammer.

(*h*) Insecure attachment of branches on spurs.

Marking of Rejected Specimens.

35. All rejected pipes shall be plainly marked by the inspector and shall be replaced by the manufacturer or seller with pipes which meet the requirements of these specifications, without additional cost to the consumer or purchaser.

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TENTATIVE SPECIFICATIONS

FOR

REQUIRED SAFE CRUSHING STRENGTHS OF SEWER PIPE TO CARRY LOADS FROM DITCH FILLING.[1]

Serial Designation: C 15 – 17 T.

These specifications are issued under the fixed designation C 15; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

The following table gives required safe crushing strengths per linear foot of pipe, to carry loads from ditch filling materials only when pipe is laid in accordance with the Tentative Recommended Practice for Laying Sewer Pipe (C 12–17 T) of the American Society for Testing Materials, for sand and for thoroughly wet clay ditch filling materials. In the preparation of this table a safety factor of 1½ has been used, which has been found necessary to prevent cracking from the loads of ditch filling.[2]

Ordinary Pipe Laying is pipe laying in accordance with customary good practice in pipe sewer construction, whereby

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Rudolph Hering, Chairman of Committee C-4 on Clay and Cement Sewer Pipe, 170 Broadway, New York City.

[2] Prepared from the Standard Specifications for Drain Tile (C 4-16), 1918 Book of A.S.T.M. Standards.

the under side of the pipe is well bedded on soil for 60 to 90 deg. of the circumference.

First Class Pipe Laying is pipe laying in accordance with the best customary practice in pipe-sewer construction, whereby the entire under side of the pipe is very thoroughly bedded on soil and the entire pipe is surrounded by well-compacted soil,

SAFE CRUSHING STRENGTHS OF SEWER PIPE TO CARRY LOADS FROM DITCH FILLING FOR ORDINARY SAND AND FOR THOROUGHLY WET CLAY DITCH FILLING MATERIALS.
(FOR ORDINARY PIPE-LAYING METHODS.)

STRENGTHS IN POUNDS PER LINEAR FOOT.

Height of Fill above Top of Pipe, ft.	Breadth of Ditch a Little Below Top of Pipe.									
	1 ft.		2 ft.		3 ft.		4 ft.		5 ft.	
	Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.	
	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.
2..........	265	280	615	635	970	990	1 330	1 350	1 690	1 710
4..........	400	450	1 055	1 125	1 745	1 825	2 455	2 535	3 165	8 250
6..........	470	545	1 370	1 500	2 370	2 525	3 405	3 575	4 460	4 640
8..........	505	605	1 600	1 790	2 875	3 115	4 215	4 495	5 595	5 890
10..........	525	640	1 765	2 015	3 275	3 610	4 900	5 295	6 590	7 020
12..........	535	660	1 880	2 185	3 600	4 030	5 485	6 000	7 460	8 035
14..........	540	675	1 965	2 320	3 855	4 380	5 975	6 620	8 225	8 950
16..........	545	680	2 025	2 425	4 065	4 675	6 395	7 165	8 890	9 775
18..........	545	685	2 070	2 505	4 230	4 920	6 750	7 630	9 480	10 520
20..........	545	690	2 100	2 565	4 365	5 130	7 050	8 060	9 995	11 190
22..........	545	690	2 125	2 610	4 470	5 305	7 305	8 425	10 445	11 795
24..........	545	690	2 140	2 645	4 560	5 455	7 525	8 750	10 840	12 340
26..........	545	690	2 150	2 675	4 630	5 575	7 705	9 035	11 185	12 830
28..........	545	690	2 160	2 695	4 685	5 680	7 860	9 280	11 490	13 270
30..........	545	690	2 165	2 715	4 725	5 765	7 900	9 500	11 755	18 670
Very great	545	690	2 180	2 770	4 910	6 230	8 725	11 075	13 635	17 306

under the direction of an inspector constantly present on the work.

When pipe are laid in a *Concrete or other Permanent Masonry Cradle*, strong enough to carry the entire load to the sub-base without breaking and large enough to prevent material settlement, the standard strengths for all dimensions of ditches and all filling materials shall be those specified for standard sewer pipe.

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TENTATIVE SPECIFICATIONS FOR MASONS' HYDRATED LIME.[1]

Serial Designation: C 6 – 17 T.

These specifications are issued under the fixed designation C 6; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

1. Masons' hydrated lime is a dry flocculent powder, resulting from the hydration of quicklime. **Definition.**

2. Masons' hydrated lime may be used for making lime mortar, for scratch or brown coat of plaster, or for addition to Portland-cement mortar or concrete. **Uses.**

I. CHEMICAL PROPERTIES AND TESTS.

3. The sample shall be a fair average of the shipment. Three per cent of the packages shall be sampled. The sample shall be taken from the surface to the center of the package. A 2-lb. sample to be sent to the laboratory shall immediately be transferred to an air-tight container, in which the unused portion shall be stored until the shipment has been finally accepted or rejected by the purchaser. **Sampling.**

4. (*a*) The chemical composition of the hydrated lime shall be determined by standard methods of chemical analysis. **Chemical Properties.**

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1. 1919, to Mr. N. G. Hough, Secretary of Committee C-7 on Lime, Arrott Bldg., Pittsburgh, Pa.

These specifications, when adopted as standard, will supercede the present Standard Specifications for Hydrated Lime (C 6-15), 1918 Book of A.S.T.M. Standards.

(*b*) *Impurities.*—The sum of the silica (SiO_2), ferric oxide (Fe_2O_3) and alumina (Al_2O_3) expressed on the sample as received shall not exceed 5 per cent.

(*c*) *Carbon Dioxide.*—Carbon dioxide in the sample as received shall not exceed 3 per cent.

(*d*) *Calcium and Magnesium Oxides.*—Calcium and magnesium oxides shall constitute not less than 90 per cent of the non-volatile portion.

II. PHYSICAL PROPERTIES AND TESTS.

Fineness. 5. (*a*) A 100-g. sample shall leave not more than 0.5 per cent of its weight on a standard 30-mesh sieve, and not more than 15 per cent of its weight on a standard 200-mesh sieve.

(*b*) The fineness test shall be made as specified in Section 12.

Constancy of Volume. 6. (*a*) A pat of mortar, covered with a skim coat of neat paste, shall be subjected to the action of steam. If the steam has no visible effect on the pat, the sample shall be reported as being "sound." If the pat disintegrates, the sample shall be reported "unsound" and the shipment rejected. If the sample cracks, pops, or shows other minor defects, it shall not be reported as either sound or unsound, but its behavior shall be noted.

(*b*) The constancy of volume test shall be made as specified in Section 13.

III. PACKING AND MARKING.

Packing. 7. (*a*) *Kind of Package.*—The hydrated lime shall be packed in either cloth or paper bags.

(*b*) *Size of Package.*—The cloth package shall contain 100 lb. net weight of hydrated lime. The paper package shall contain 50 lb. net weight of hydrated lime.

Marking. 8. Each package shall be clearly marked to show the net weight of hydrated lime contained in the package, the name of the manufacturer, and the name of the brand, if any.

IV. INSPECTION AND REJECTION.

Inspection. 9. (*a*) All hydrated lime shall be subject to inspection.

(*b*) Hydrated lime may be inspected either at the place of manufacture or the point of delivery, as arranged at the time of purchase.

(*c*) The manufacturer shall furnish the inspector all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere with the operation of the works.

(*d*) The purchaser may make the tests to govern the acceptance or rejection of the hydrated lime in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection. 10. Unless otherwise specified, any rejection based on failure to pass tests prescribed in these specifications shall be reported within five working days from the taking of samples.

Rehearing. 11. Samples which represent rejected hydrated lime shall be preserved in air-tight containers for five days from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

V. METHODS OF TEST.

Method for Determining Fineness. 12. Fineness shall be determined as follows:

(*a*) *30-Mesh.*—Spread out a sufficient portion of the sample in a thin layer in a suitable vessel and dry to constant weight in a drying oven at a temperature between 100 and 120° C. Place 100 g. of this dried sample on a standard 30-mesh sieve and pass as much of it as possible through the sieve by shaking. The operation shall be considered completed when not more than 0.1 g. of material passes through the sieve during one minute's shaking. Collect the residue on the sieve and weigh. Calculate the weight as percentage of the dried material.

(*b*) *200-Mesh.*—Carefully collect the material which passed through the 30-mesh screen in a suitable dish and mix with enough water to form a stiff paste. Transfer this paste to a standard 200-mesh sieve and wash thoroughly with running water. A small piece of rubber tubing attached to a water faucet will be found convenient. The velocity of the stream of water can be increased by pinching the tubing, but it should not be sufficient to cause any danger of splashing the sample over the sides of the sieve. Continue the washing until the water coming through the sieve is clear. Then dry the residue to constant weight in a drying oven whose temperature is maintained between 100 and 120° C. Calculate the weight of this residue

as percentage of the dried material and to the result add the percentage residue on the 30-mesh sieve. The sum of the two shall be reported as the residue on the 200-mesh sieve.

Method for Determining Constancy of Volume.

13. Constancy of volume shall be determined as follows:

To 20 g. of the sample, add 100 g. of clean, washed, graded sand which shall all pass the No. 20 sieve and which shall all be retained on the No. 100 sieve. Mix thoroughly and add enough water to make a good plastic mortar of a rather dry consistency. Spread out on a clean glass plate, to form a layer about $\frac{1}{8}$ in. thick by about 4 in. square. The pat shall be of even thickness throughout, and not tapering at the edges. If the mortar is too dry to work well, add more water. Place this pat in a closet to set for 24 hours. The temperature in the closet should be between 65 and 75° F., and there should be free circulation of air in the closet, without allowing any direct draft to hit the pat. At the end of 24 hours remove the pat from the closet and soak it in water, until a film of water stands unabsorbed on the surface of the pat. Examine the pat carefully for cracks. If any are found, too much water was used in making the pat, and it should be discarded and a new one made.

Mix 20 g. of the sample with enough water to form a thick cream. Spread this out in a thin layer on the surface of the pat. Let it stand for 15 minutes to permit possible air bubbles to form. Trowel to a smooth even surface, making this skim coat as thin as possible without allowing the sand to show through. Put the pat back in the closet for another 24 hours, so that the skim coat can set. Examine carefully, to insure the absence of any cracks or pops. Provide a vessel partially filled with cold water, and having a perforated cover. Suspend the pat in this vessel in such a way that the water can boil without touching it. Gradually bring the water to a boil, and keep it boiling gently for 5 hours, the pat being surrounded by steam during this time. Turn out the fire, and permit the water to cool for at least 12 hours before the cover is removed from the vessel. The pat is then removed and examined for cracking, popping or disintegration.

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TENTATIVE TEST FOR REFRACTORY MATERIALS UNDER LOAD AT HIGH TEMPERATURES [1]

Serial Designation: C 16 – 18 T.

This test is issued under the fixed designation C 16; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

1. The object of the test is to determine the resistance of the specimen to deformation at a specified temperature for a specified time, when subjected to a compressive load of 25 lb. per sq. in. (1.765 kg. per sq. cm.). **Object.**

2. The apparatus consists essentially of a furnace and loading device It shall be constructed in accordance with Figs. 1 and 2. **Apparatus.**

(*a*) The furnace shall be cylindrical in form, 18 in. (457 mm.) in internal diameter, as shown in Fig. 1 (Plate VIII).

(*b*) The heating shall be done with gaseous or oil fuel and compressed air, using not less than two burners located tangentially and so arranged that no flame can impinge upon the test specimen. The burners shall be such as will insure a uniform temperature in all parts of the furnace and be under complete control.

(*c*) The method of loading shown in Fig. 1 shall be

[1] Criticisms of this Tentative Test are solicited and should be directed, preferably before January 1, 1919, to Mr. A. V. Bleininger, Chairman of Committee C-8 on Refractories, Bureau of Standards, Pittsburgh, Pa.

used, and the details shall be such as will insure accuracy in the applied load and freedom from eccentric loading, both in the original application and during the testing. It is advantageous to make the cross-beams as light as possible, so that

TABLE I.—TEMPERATURE TO BE ATTAINED AT TIME SPECIFIED.

ALL TEMPERATURES IN DEGREES CENTIGRADE.

Time.		Silica.	Fire Clay.		
			Heavy Duty.	Moderate Duty.	Light Duty.
Hr.	Min.				
	15	40	160	160	160
	30	80	280	280	280
	45	140	400	400	400
1	0	200	500	500	500
	15	260	620	595	570
	30	290	720	685	640
	45	300	815	770	700
2	0	310	900	850	755
	15	320	980	920	810
	30	385	1045	990	860
	45	490	1100	1050	905
3	0	590	1150	1100	950
	15	695	1195	1145	985
	30	800	1235	1185	1020
	45	900	1270	1220	1050
4	0	1000	1300	1250	1075
	15	1100	1330	1275	1090
	30	1200	1350	1300	1100
	45	1250	1350	1300	1100
5	0	1300	1350	1300	1100
	15	1350	1350	1300	1100
	30	1380	1350	1300	1100
	45	1410	1350	1300	1100
6	0	1440	1350	1300	1100
	15	1470	End	End	End
	30	1500			
	45	1500			
7	0	1500			
	15	1500			
	30	1500			
	45	1500			
8	0	1500			
		End			

the greater portion of the load may be concentrated in the weights.

(*d*) The temperature may be measured either with a calibrated platinum-rhodium thermo-couple, encased in a double protecting tube with the junction not more than 1 in. (25 mm.) from the side or edge of the specimen and approximately opposite

TENTATIVE TEST FOR REFRACTORY MATERIALS.

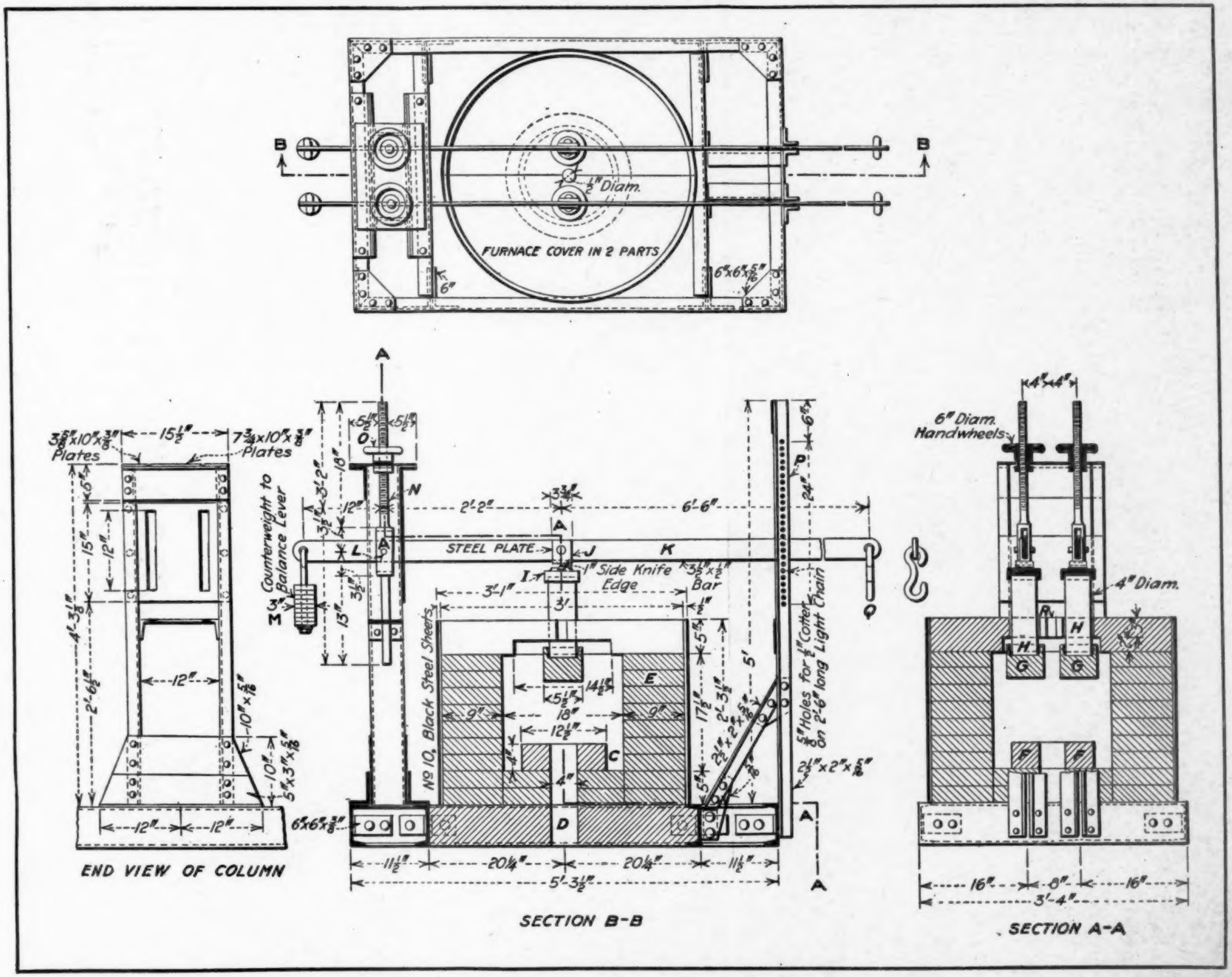

FIG. 1.—Apparatus for Testing Refractory Materials under Load at High Temperatures.

(By courtesy of *Metallurgical and Chemical Engineering.*)

the center; or with some form of optical pyrometer that has been calibrated against a thermo-couple in the furnace. If the thermo-couple is used, the cold-end temperature should be kept

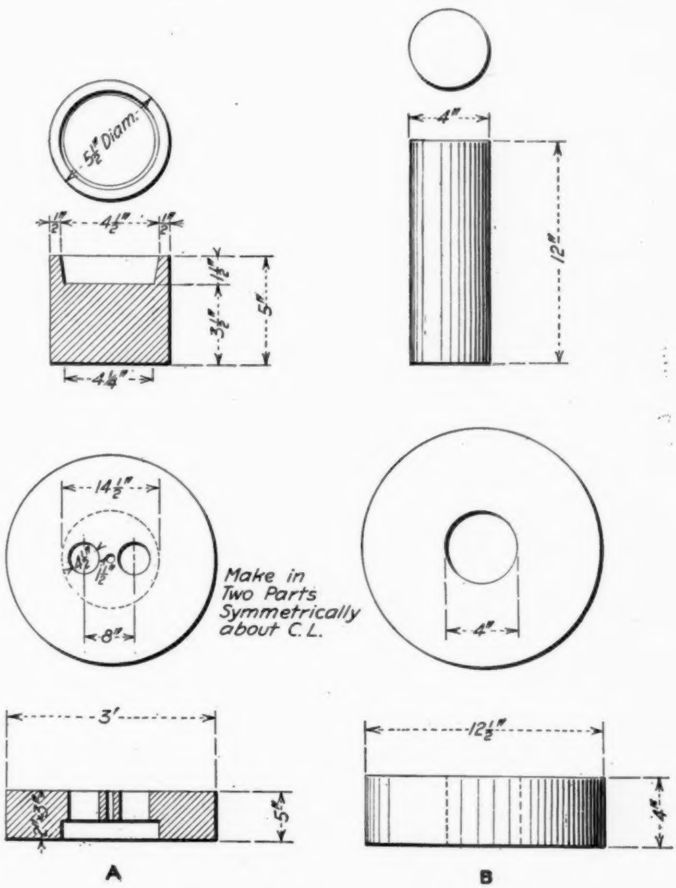

FIG. 2.—Special Shapes Required for Furnace.
(By courtesy of *Metallurgical and Chemical Engineering.*)

constant in melted ice. A recording form of indicator is recommended where possible.

3. The test specimen shall consist, whenever possible, of a standard 9-in. brick placed vertically on end. In the case of **Test Specimen.**

blocks or shapes, sections approximately 9 by $4\frac{1}{2}$ by $2\frac{1}{2}$ in. (228 by 114 by 64 mm.) shall be cut, utilizing as far as possible existing plane surfaces. The ends of the specimen shall be either ground so that they are parallel and perpendicular to the vertical axis, or if this is impossible, shall be bedded in a

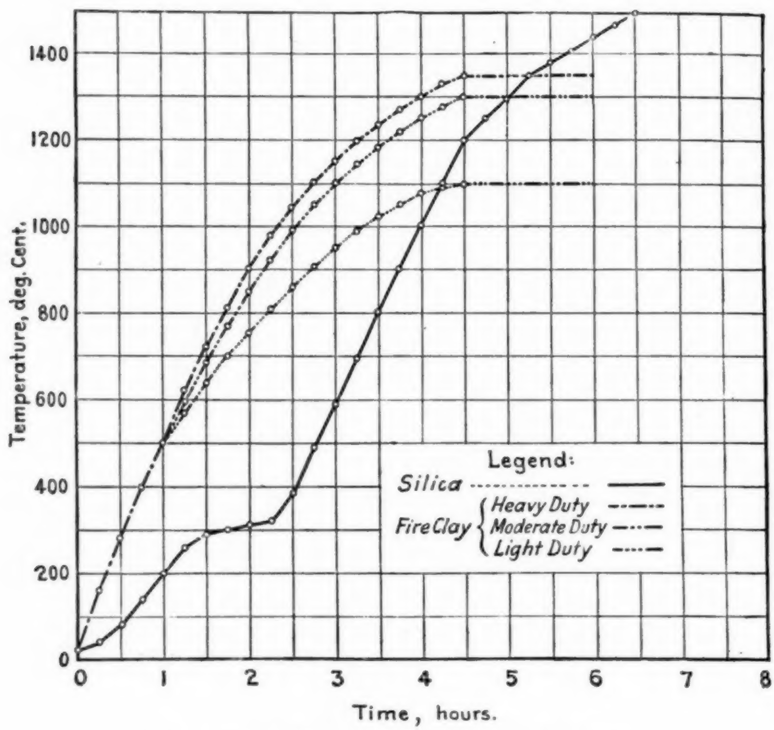

FIG. 3.—Time-Temperature Curve for Load Test.

neutral cement, so that the specimen is perpendicular to the base of the furnace.

The test specimen shall be measured before testing, making not less than five observations in each direction to within ±0.02 in. (0.5 mm.). The average dimensions shall be reported, and the cross-section calculated.

Starting the Test. 4. The test specimen shall occupy approximately the center of the furnace and should rest on a block of some highly refrac-

tory material, having a minimum expansion or contraction. A silicon-carbide brick has been found satisfactory. At the top of the test specimen a block of similar highly refractory material should be placed, extending through the furnace top to receive the load.

Heating. 5. The rate of heating shall be in accordance with the requirements of Table I and the time-temperature curves of Fig. 3, which give the rate and time of heating suggested for different grades of material.

Loading. 6. (*a*) The load is calculated from the average cross-section as determined on the untested specimen and the requirement of the test. It is recommended that for general purposes, 25 lb. per sq. in. (1.765 kg. per sq. cm.) be used.

(*b*) The additional masses required to give the desired loading should be equally distributed on each side of the beam.

Completing the Test. 7. (*a*) At the expiration of the time of heating, the supply of heat shall be stopped and the furnace allowed to cool, during not less than 5 hours before removing the load and examining the test specimen.

(*b*) After the test specimen has cooled to the room temperature, it shall be remeasured as before described, and the change in length recorded and reported as percentage of the original length.

(*c*) It is recommended that a photograph be made of the specimen before and after testing, as yielding valuable information at a minimum time and expense.

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TENTATIVE TEST

FOR

SLAGGING ACTION OF REFRACTORY MATERIALS.[1]

Serial Designation: C 17 – 17 T.

This test is issued under the fixed designation C 17; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Preparation of Samples.

1. Select three or more of the bricks to be tested. Draw upon the smooth or unbranded side a line bisecting each brick across the narrow dimension. Draw diagonals across each half. At the points of intersection of the diagonals drill circular cavities $2\frac{1}{2}$ in. in diameter and $\frac{1}{2}$ in. deep on the sides. The drill used shall be $\frac{5}{16}$ in. in thickness, the point shall be tapered to include an angle of 150 deg., and the width of the bit shall be such as to cut a hole $2\frac{1}{2}$ in. in diameter. The cavity after drilling shall be checked up by a standard template, and shall conform to the same as nearly as the nature of the material permits. All loose material, dust and cuttings shall be carefully removed from each cavity.

[1] Criticisms of this Tentative Test are solicited and should be directed, preferably before January 1, 1919, to Mr. A. V. Bleininger, Chairman of Committee C-8 on Refractories, Bureau of Standards, Pittsburgh, Pa.

Preparation of the Slag to be Used as a Solvent

2. A slag,[1] selected with reference to the purpose for which the bricks are to be used, shall be employed as the solvent. This slag shall be ground until it will pass a 40-mesh sieve

The Heat Treatment.

3. The bricks shall be placed level on the hearth of a cold furnace and heated to 1350° C., attaining this tempefrature in a time not shorter than 5 hours Thirty-five grams of powdered slag shall then be introduced by a metal spoon or equivalent device, avoiding scattering it upon the margins of the cavity. The temperature shall then be held as nearly as possible at 1350° C. for 2 hours; the fluctuations should not exceed 10° C., above or below this point. The furnace shall then be allowed to cool without removing the bricks.

Measuring the Penetration.

4. When cold, the bricks shall be sawed so that one of the sawed surfaces accurately bisects the center of the original cavity.[2] The slag will be found to have discolored the brick into which it has penetrated more or less deeply. For measuring the area affected, a planimeter is used. The extreme outer margin of the discolored area shall be traced with the planimeter, and the unaffected upper portion of the original cavity also circumscribed. From the area in square inches thus obtained deduct the area of the original cavity, 1.7 sq. in.; the difference is the area of the brick penetrated and discolored by the slag.

[1] The slags used in the development of this test were selected as representing the iron and steel industry and were of the following chemical composition:

	Blast-Furnace Slag.	Heating-Furnace Slag.	Open-Hearth Slag.
Silica (SiO_2), per cent	38.0	35.0	18.4
Iron (Fe), per cent	1.5	44.0	14.5
Manganese (Mn), per cent	1.0	0.5	5.1
Alumina (Al_2O_3), per cent	14.5	6.0	3.8
Lime (CaO), per cent	42.0	1.5	44.1
Magnesia (MgO), per cent	2.0	0.5	6.3
Sulfur (S), per cent	1.0	...	0.4

[2] The wheel used for sawing the brick is a carborundum wheel, 12 in. in diameter, ⅜ in. thick, 1¼ in. diameter of center hole, grit 16, bond NCH. This wheel is known as a vulcanite wheel.

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TENTATIVE METHODS
FOR
ULTIMATE CHEMICAL ANALYSIS OF REFRACTORY MATERIALS.[1]

Serial Designation: C 18 - 18 T.

These methods are issued under the fixed designation C 18; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

Prefatory Note.—It will be understood that the making of a complete silicate analysis is a difficult procedure requiring a wide knowledge of the chemistry involved in the operations, and a thorough training in carrying out the work. A skilled analyst of good training is therefore required to do the work. The descriptions here given cover the vital points of procedure, but frequent reference in regard to the details of the various manipulations must be made to *Bulletin No. 422*, United States Geological Survey on "Analysis of Silicate and Carbonate Rocks," by W. F. Hillebrand; also, to "Treatise on the Ceramic Industries," Vol. 1 (1913), by J. W. Mellor; and to similar publications.

I. GENERAL CONSIDERATIONS.

Grinding of Sample. 1. The sample shall be crushed in a hardened tool-steel mortar, using a pestle of the same sort. Fine grinding shall be done in an agate mortar, either by hand, or by a mechanical sample grinder of the McKenna, Carling or similar type, so constructed as to prevent the introduction of impurity.

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[1] **Criticisms of these Tentative Methods are solicited and should be directed, preferably before January 1, 1919, to Mr. A. V. Bleininger, Chairman of Committee C-8 on Refractories, Bureau of Standards, Pittsburgh, Pa.**

2. Moisture shall be determined in the sample in its ordinary air-dried condition, and all other percentage compositions shall be calculated to a moisture-free basis. Whenever a sample is weighed out for any determination, a moisture determination shall also be made. If preferred, the sample may be dried in a weighing bottle, from which the required samples shall be weighed out. **Statement of Analysis.**

3. In all cases, check determinations shall be made, and the results shall be redetermined if satisfactory checks are not obtained. It shall be considered satisfactory if the differences between check determinations do not exceed the following limits: **Checking Results.**

For silica or other constituent amounting to 30 per cent or over	0.3 per cent
For alumina or other constituent amounting to 10–30 per cent	0.2 per cent
For any other constituent amounting to under 10 per cent	0.1 per cent

These figures are stated in terms of the whole sample as 100 per cent.

II. SOLUTIONS REQUIRED.

4. The acids referred to as concentrated shall be of approximately the following specific gravities: **Concentrated Acids.**

Hydrochloric Acid (HCl)	1.20
Sulfuric Acid (H_2SO_4)	1.84
Nitric Acid (HNO_3)	1.42

5. Dissolve 1.5 g. of ammonium carbonate in 50 cc. of cold water. **Ammonium Carbonate.**

6. Dissolve 107 g. of NH_4Cl in 1000 cc. of warm water. **Ammonium Chloride.**

7. Neutralize 20 cc. of concentrated HNO_3 with NH_4OH and dilute to 1000 cc. Test with litmus; the solution shall not be acid. **Ammonium Nitrate.**

8. Dissolve 1 g. of ammonium oxalate in 50 cc. of water, heating gently. **Ammonium Oxalate.**

9. The strength of the final standard titania solution shall be 1 cc. = 0.0001 g. TiO_2. To prepare the solution weigh out in **Standard-Titania Solution.**

a platinum crucible an amount of potassium titanium fluoride (K_2TiF_6) sufficient to make from ½ to 1 liter of "stock solution" in which 1 cc. = 0.001 g. TiO_2. Evaporate several times with H_2SO_4 without taking to dryness, thus driving out all fluorine. Take up the residue with water containing enough H_2SO_4 to make at least 5 per cent of the solution, when finally diluted to the standard solution strength. To standardize the stock solution take out two 50-cc. portions, dilute, boil and precipitate with ammonia. Filter, wash with hot water until free from alkali, ignite, blast and weigh. The duplicate should check very closely. From the weight of titania thus determined calculate the strength of the stock solution. The standard solution to be used is obtained from the stock solution by diluting until 1 cc. = 0.0001 g. (TiO_2).

Standard Potassium-Permanganate Solution.

10. Dissolve about 0.4 g. (a little less) of $KMnO_4$ in 1 liter of water and check against an iron solution of known purity and strength. Dilute the solution until 1 cc. = 0.001 g. Fe_2O_3

The ordinary chemical iron wire is not sufficiently pure for this use. If preferred the solution may be standardized against sodium oxalate, a pure form of which is prepared especially for such work by the U. S. Bureau of Standards, Washington, D. C.

III. METHODS.

MOISTURE.

Moisture.

11. To determine moisture, heat approximately 1 g. of the sample at a temperature not under 105 nor over 110° C., to constant weight.

IGNITION LOSS.

Ignition Loss.

12. To determine loss on ignition, heat about 1 g. of the sample over a blast lamp or in an electric furnace at 900 to 1000° C., to constant weight. Ignition loss may be determined in the sample from which the moisture has been removed. The percentage of ignition loss is calculated to a moisture-free basis.

SILICA.

Silica.

13. To determine silica, weigh out approximately 0.5 g. of the sample and mix with 5 g. of Na_2CO_3. Put a little Na_2CO_3 in the bottom of the crucible before introducing the mixture, and

then cover the mixture with a little more Na_2CO_3. Fuse over a Meker burner or blast lamp until complete solution is obtained. Cool the fusion and as it solidifies, rotate the crucible to spread the mass up the side walls. Dissolve the fusion in about 100 cc. of water in a platinum or porcelain evaporating dish. Add about 20 cc. of concentrated HCl, introducing it slowly by means of a pipette, keeping the dish covered with a watch glass. Evaporate to dryness and heat until the fumes of HCl are gone. Add about 5 cc. of concentrated HCl and 30 to 40 cc. of water. Warm on a water bath for 10 to 15 minutes and break up the lumps. Decant the clear liquid onto a filter paper and collect the filtrate in a 400-cc. beaker. Add more HCl and water to the evaporating dish, warm again and decant. Repeat this a third time.

Finally transfer the contents of the dish to the filter paper. Wash with cold water until silver nitrate shows no chlorides to be left. Transfer the filtrate to the original evaporating dish, evaporate again to dryness, take up with a little HCl and water, transfer to a new filter paper and wash as before. Transfer both silica precipitates to a platinum crucible. Ignite carefully over a Bunsen flame until the filter paper is burned off, then blast for about 30 minutes; cool and weigh. Repeat blasting for 5 minutes, weigh again and repeat until constant weight is obtained.

To the residue in the crucible add about 5 cc. of water and 5 drops of H_2SO_4. Add HF drop by drop at first, and then slowly until the crucible is almost one-half filled. Warm on a hot plate until almost dry, add 2 or 3 cc. more of HF and evaporate to dryness. Heat the crucible to bright redness and then blast for 5 minutes. Cool and weigh and repeat blasting to constant weight. The loss in weight from the original silica residue represents the actual silica content (SiO_2), except for that part of silica which is later recovered from alumina, etc. The residue from the HCl evaporation is left in the crucible and the total precipitate of alumina, etc., is added to this same crucible in which it is ignited and weighed.

ALUMINA.

14. Regarding the determination of alumina, reference should be made to *Scientific Paper No. 286* of the U. S. Bureau of Standards by Dr. Blum on "Determination of Alumina as Oxide." **Alumina.**

To determine alumina, to the filtrate from the silica determination, add about 10 cc. of NH_4Cl solution and heat to boiling. Then add NH_4OH very slowly and with constant stirring until there is a slight excess. The NH_4OH must be free from CO_2. Filter hot and rapidly, and wash four times by decantation with hot solution of ammonium nitrate. Carefully wash the precipitate from the filter paper into a beaker, using hot water. Dissolve the precipitate in hot dilute HCl. Repeat the precipitation with NH_4Cl and NH_4OH. Decant four times as before, using hot ammonium nitrate. Transfer to the filter paper and wash with hot ammonium nitrate until the washings are free from chlorides when tested by silver nitrate. Evaporate the filtrate nearly to dryness, add a little NH_4OH and continue the evaporation. Keep the solution alkaline to coagulate any iron and aluminum hydroxides. Transfer the precipitate to a filter paper and wash thoroughly. Transfer the moist filter paper to the platinum crucible containing the residue from the silica. Burn off the filter paper and blast the precipitate. Repeat blasting and weighing to a constant weight.

IRON OXIDE.

Iron Oxide. 15. To determine iron oxide, fuse the ignited alumina precipitate with about six times its weight of potassium pyrosulfate or potassium bisulfate. Avoid sputtering. Heat carefully to redness and continue heating until the residue is all dissolved. Cool. Dissolve in warm water and add about 10 cc. of dilute H_2SO_4 (1:5). Evaporate to a small volume. Then heat to a higher temperature until copious fumes of H_2SO_4 are evolved. Sufficient H_2SO_4 should be present to form a pasty mass when cooled. Take up with water, filter off, wash, ignite and weigh the silica as before and evaporate with HF as before. The loss in weight is extra silica to be added to the original silica determination and subtracted from the alumina. Fuse the residue with a little potassium pyrosulfate or potassium bisulfate, and add the solution of this cake to the main solution. Transfer the total filtrate to a 250-cc. graduated flask and dilute to 250 cc. ,mixing thoroughly. Draw off 50 cc. of this solution and reserve for titania determination. Pass the remaining 200 cc. through a Jones reductor, or other-

wise reduce the solution with pure zinc and H_2SO_4. To the solution add 3 cc. of 10-per-cent $CuSO_4$ solution and titrate with standard $KMnO_4$ solution (1 cc. equivalent to 0.001 g. Fe_2O_3), until a faint pink tinge is seen. If Jones reductor or similar apparatus is used, subtract the $KMnO_4$ equivalent, which has previously been determined on blank samples run through the apparatus. From the result, calculate the iron as Fe_2O_3.

TITANIA.

16. To determine titania, place in a small Nessler tube the 50 cc. of filtrate previously set aside for titania determination, and fill the tube up to the graduation mark. Add 1 cc. of H_2O_2 (free from fluorine) and shake well. The color of this solution is now compared in any standard color comparator with the color of a known standard solution, preferably of such strength that 1 cc. equals 0.0001 g. of titanium dioxide (TiO_2). To make the comparison, put 10 cc. of this standard solution into a second small Nessler tube and dilute with water from a burette until the color is matched. Note the amount of water added and calculate the percentage of TiO_2 in the sample. **Titania.**

LIME.

17. To determine lime, evaporate the filtrate from the alumina precipitation to about 250 cc. While still boiling add about 5 cc. of acetic acid. Meanwhile, dissolve about 1 g. of oxalic acid in a little hot water and add to the solution. In about 5 minutes add a slight excess of NH_4OH and boil until precipitation is complete. Cool thoroughly and filter. Wash three times by decantation with dilute NH_4OH (1 : 10) or a 1-per-cent solution of ammonium oxalate. Dissolve the precipitate by adding about 50 cc. of dilute HNO_3 (1 : 5). Again add a slight excess of NH_4OH and a few drops of oxalic-acid solution. Boil well and let stand a couple of hours to cool. Filter and wash as before. Transfer the precipitate to a platinum crucible, carefully burn off the paper and ignite over a blast lamp for about 10 minutes. Cool and weigh quickly. Repeat the blasting to constant weight. The increase in weight of crucible is calcium oxide. **Lime.**

MAGNESIA.

Magnesia. 18. To determine magnesia, add to the filtrate from lime precipitation about 2 g. of sodium-ammonium-phosphate dissolved in 15 cc. of water. Stir vigorously and while stirring add drop by drop about one-third of the volume of the solution of NH_4OH. Let stand 12 to 24 hours. Filter and wash the precipitate with dilute NH_4OH (1 : 10). Discard the filtrate. Wash the precipitate until the washings show no discoloration when tested with silver nitrate. Redissolve the precipitate in warm dilute HNO_3 (1 : 5), using about 50 cc., and collect in a beaker. Precipitate and wash as before. Collect the precipitate on a Gooch asbestos crucible. Dry slowly and then heat over a Meker burner for about 10 minutes; cool and weigh. Re-ignite to constant weight.

The $Mg_2P_2O_7$ is never pure, being contaminated by small amounts of calcium, barium, aluminum, iron, manganese, etc., but in the analysis of refractories this error is negligible, and correction for these impurities is not required unless previously agreed upon.

ALKALIES.

Alkalies. 19. To determine alkalies, the J. Lawrence Smith method shall be used. Weigh out about 0.5 g. of the sample and mix well with 0.5 g. of NH_4Cl and 3 g. of $CaCO_3$. Transfer to a platinum crucible, placing about 0.5 g. of $CaCO_3$ in the bottom of the crucible and a similar amount over the top of the mixture. Heat gently over a low flame for about 15 minutes to volatilize NH_4Cl. Then raise the temperature until the lower three-quarters of the crucible is dull red. Hold this temperature for about one hour. Cool, take up with about 50 cc. of water and heat over a water bath, adding water to replace that lost by evaporation. Break up any lumps with a small pestle. Decant the clear liquid through a filter paper and wash four times by decantation. Then transfer the residue to the filter. Wash until silver nitrate shows only a very faint turbidity. To the filtrate add NH_4OH and ammonium carbonate and heat to boiling. Filter and again digest the precipitate with NH_4OH and ammonium carbonate. Filter and allow the filtrate to collect with the previous filtrate, then evaporate to dryness in a plat-

inum or porcelain dish. Remove ammonium salts by gentle ignition in a moving flame. Treat with water and remove the last trace of lime by adding ammonium oxalate to the boiling solution and let stand over night. Filter, evaporate to dryness, ignite gently and allow to cool. Then moisten the residue with HCl, evaporate again to dryness, ignite gettly and weigh. Dissolve in water. Ignite and weigh any insolublc residue, deducting this from the alkali chlorides.

Dilute the solution of the mixed chlorides and add hydrochloroplatinic acid in amount equal to 0.3 cc. more than would be necessary if all chlorides were present as NaCl. Evaporate to a syrupy consistency. Cool and treat with a few cubic centimeters of 80-per-cent ethyl alcohol. Stir and decant through a weighed Gooch crucible. Treat again with 80-per-cent alcohol and decant. Repeat washing and decantation until the alcohol leaving the Gooch crucible is colorless and the precipitate appears golden yellow, not orange. Transfer the precipitate to the Gooch crucible, wash with 80-per-cent alcohol about six times and dry at 130° C. to constant weight. This residue is potassium chloroplatinate.

The oxides are calculated as follows:

Weight of potassium chloroplatinate $\times 0.3068 = KCl$.
Weight of potassium chloroplatinate $\times 0.1941 = K_2O$.
Total chlorides $- KCl = NaCl$.
$NaCl \times 0.5303 = Na_2O$.

AMERICAN SOCIETY FOR TESTING MATERIALS

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TENTATIVE METHOD

FOR

DETERMINATION OF POROSITY AND PERMANENT VOLUME CHANGES IN REFRACTORY MATERIALS.[1]

Serial Designation: C 20 – 18 T.

This method is issued under the fixed designation C 20; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Object.

1. The object of this test is to determine the porosity and permanent volume changes in refractory materials when heated to series of specified temperatures.

Preparation of Test Specimens.

2. (*a*) The sample shall consist of at least seven standard-size bricks.

(*b*) Test specimens measuring $2\frac{1}{2}$ by $2\frac{1}{2}$ by $1\frac{1}{4}$ in. shall be cut so as to remove the original surfaces of the bricks; for this a "cut off" grinding wheel is recommended. There should be five test specimens for each of the seven heat treatments specified in Section 4 or 35 test specimens for each kind of brick. The test specimens shall be brushed or washed free from all

[1] Criticisms of this Tentative Method are solicited and should be directed, preferably before January 1, 1919, to Mr. A. V. Bleininger, Chairman of Committee C-8 on Refractories, Bureau of Standards, Pittsburgh, Pa.

adhering dust and marked serially with a refractory stain, for which 5-per-cent cobalt-kaolin mixture is suggested.

Procedure. 3. After the test specimens have been cut and cleaned, they shall be dried and the volumes and porosity of each obtained as described in Sections 5 and 6. They shall be heated as specified in Section 4, and the changes in volume and porosity determined.

Burning. 4. (*a*) Dry the test pieces prior to placing in the kiln.

(*b*) Raise the temperature as rapidly as is consistent with even heat distribution to 1200° C. From 1200° C. raise the temperature at the rate of 30° per hour, drawing samples at each 50° interval from 1200 to 1500° C.

(*c*) If it is possible and the number of brands being tested warrant, it is best that separate burns to each temperature be made and the kiln sealed and allowed to cool by radiation. In case separate burns cannot be made, the five test specimens from each temperature increment should be covered with hot sand immediately on being drawn; or placed in a supplementary furnace and kept at about 500° C. until all drawings are completed, and then cooled with the furnace sealed to cool wholly by radiation.

Method of Obtaining Data. 5. (*a*) The test specimens shall be cleaned from adhering or loosely attached pieces and particles, care being taken not to alter the exterior volume as originally prepared for this test.

(*b*) The test specimens shall be heated if necessary to 110° C. to remove moisture, and their dry weight (D) obtained to 0.10 g.

(*c*) The test specimens shall be placed in kerosene of known density (δ) under a vacuum of 24 in. for 4 hours at 25° C. and cooled to room temperature while yet immersed.

(*d*) When cool, each test specimen shall be weighed suspended in kerosene at 25° C. to determine its "suspended weight" (S), in grams.

(*e*) The "saturated weight" (W), in grams, of each test specimen shall be obtained immediately after obtaining the suspended weight, by drying lightly with a kerosene-moistened towel to remove the excess kerosene and then weighing in air.

(*f*) The *Exterior Volume* (V), in cubic centimeters, of each test specimen is obtained by subtracting the suspended weight

(S) from the saturated weight (W), and dividing by the density (δ) of the kerosene. Thus,

$$V = \frac{W - S}{\delta} \quad \text{.....................(1)}$$

(*g*) The *Actual Volume of Open Pores* (V_1), in cubic centimeters, is obtained by subtracting the dry weight (D) from the saturated weight (W), and dividing by the density (δ) of the kerosene. Thus:

$$V_1 = \frac{W - D}{\delta} \quad \text{.....................(2)}$$

(*h*) The *Apparent Specific Gravity* (T_1) of that portion of the test specimen which is impervious to liquid is obtained by dividing the dry weight by the difference between the dry and suspended weights, and multiplying by the density of the kerosene. Thus,

$$T_1 = \frac{D}{D - S}\,\delta \quad \text{.....................(3)}$$

(*i*) The *True Specific Gravity* (T) of the wholly solid or burned clay portion is obtained by crushing a portion of the dried test specimen to 120-mesh powder and determining the displacement at 25° C. under 24 in. vacuum, of a 20-g. sample in a 50-cc. straight-wall pyknometer using kerosene, and correcting for density of the kerosene.

(*j*) The *Volume of Sealed Pores* (V_2), in cubic centimeters, is obtained by subtracting the quotient of dry weight (D) divided by true specific gravity (T) from the volume of the impervious portion of the test specimen; or

$$V_2 = \frac{(D - S)}{\delta} - \frac{D}{T} \quad \text{...............(4)}$$

(*k*) The *Volume Shrinkage* is obtained by subtracting the volumes, that is, the values of $\frac{W - S}{\delta}$, before and after the heat treatment.

Basis of Reference for the Data.

6. To show progressive changes in the several volumes, refer all volumes back to the original exterior volume of the test specimen as 100. This is done by multiplying all volumes

by the factor $100/V$, in which V is the exterior volume of the test specimen prior to the subjection to heat treatment.

The volume data should be determined for each test specimen and multiplied by the above factor to reduce all volumes for each test specimen to terms of 100 original exterior volumes of that test specimen before the average of the five for each heat treatment is calculated.

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TENTATIVE DEFINITIONS

OF

TERMS RELATING TO THE GYPSUM INDUSTRY.[1]

Serial Designation: C 11 – 16 T.

These definitions are issued under the fixed designation C 11; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916.

SYNOPSIS.

These definitions are divided into fifteen parts, under the following titles:

I. GYPSUM: ITS FORMS, FUNCTIONS AND PRODUCTS.

Giving the various forms in which gypsum is used, its functions in the various classes of products, and a list of these products classified according to these functions.

II. CEMENTITIOUS BASE PRODUCTS.

A development of the products classified according to the first function given under Part I.

III–VII.

A skeleton outline of the development of products classified according to the remaining functions given under Part I.

VIII. CLASSES, TYPES AND FORMS OF CEMENTITIOUS BASE PRODUCTS.

A development of the classes, types and forms of the products given in

[1] Criticisms of these Tentative Definitions are solicited and should be directed, preferably before January 1, 1919, to Mr. V. G. Marani, Secretary of Committee C-11 on Gypsum, 1611 Harris Trust Bldg., Chicago, Ill.

Part II. The plan is to give the definition of each product as it is listed, it being the intention that this arrangement will show the reason for the adoption of certain terms, and for the avoidance of other terms.

IX-XIII.

To be a development, similar to Part VIII, of the classes, types and forms of the products given in Parts III-VII.

XIV. GLOSSARY.

Contains a list of the ingredients used in gypsum products with their definitions, and a list of terms the use of which should be avoided if possible.

XV. APPENDIX.

Contains a discussion of the reasons for the adoption or avoidance of all of the foregoing terms.

I. GYPSUM: ITS FORMS, FUNCTIONS AND PRODUCTS.

(A) FORMS.

1. Gypsum is used in the arts in two forms: **Forms.**

(a) Uncalcined.

(1) Mass.

(2) Crushed.

(3) Ground.

(b) Calcined.

(B) FUNCTIONS.

2. Gypsum is used to function in several distinct ways: **Functions.**

(a) As a cementitious base.

(b) As a chemical.

(c) As a pigment.

(d) As a filler.

(e) As a flux.

(f) As a (other functions to follow).

(C) PRODUCTS.

3. Gypsum is mixed with other materials in the following classes of products: **Products.**

(a) As a cementitious base in

(1) Coatings—applied in plastic form.

(2) Bondings—applied in plastic form.

(3) Structural products.
(4) Cast products.
(5) Pottery products.

(*b*) As a chemical in
(1) Fertilizers.
(2) Portland-cement manufacture.
(3) Sulfuric-acid manufacture.
(4) Brewing industry.

(*c*) As a pigment in
(1) Paints, oil, or water.

(*d*) As a filler in
(1) Paper.
(2) Cloth.

(*e*) As a flux in
(1) Brass melting.

(*f*) As a carrier for
(1) Paris green.

II. CEMENTITIOUS BASE PRODUCTS.

(*A*) COATINGS.

Coatings. 4. Coatings applied in a plastic form are sub-divided as follows:

(*a*) *Plaster.*—A material used in a plastic state to form a hard covering for the *interior* surfaces, walls, ceilings, etc., of any building or structure. The word "plaster" is used without regard to the composition of the material, defining only its use and location of use as contrasted with the words "stucco" and "mortar."

For Gypsum Plaster, see Part VIII, Section 22 (*c*) *1*.

(*b*) *Stucco.*—A material used in a plastic state to form a hard covering for the *exterior* walls or other *exterior* surfaces of any building or structure. The word "stucco" is used without regard to the composition of the material, defining only its use and location of its use,

as contrasted with the words "plaster" and "mortar."

For Gypsum Stucco, see Part VIII, Section 22 (*c*) *2*.

(*B*) BONDINGS.

5. Bondings applied in a plastic form are sub-divided as follows: **Bondings.**

(*a*) *Mortar.*—A material used in a plastic state, becoming hard in place, to bond together such materials as brick, stone, tile, gypsum blocks, terra cotta, etc., in building walls, partitions, columns, foundations, piers, floors, and roof arches, etc. The word "mortar" is used without regard to the composition of the material, defining its use as a bonding material, as contrasted with the words "stucco" and "plaster."

For Gypsum Mortar, see Part VIII (*B*)—(Definition to follow.)

(*C*) STRUCTURAL PRODUCTS.

6. Gypsum structural products are sub-divided as follows: **Structural Products.**
(Definitions to follow.)

(*a*) *Gypsum Plaster Boards.*

(*b*) *Gypsum Blocks* are sub-divided as follows:

(1) Floor tile.
(2) Book tile.
(3) Roof tile.
(4) Partition blocks.
(5) Furring tile.
(6) Column covering.

(*c*) *Concrete* is sub-divided as follows:

(1) Arches—floor and roof.

(*D*) CAST PRODUCTS.

7. Gypsum cast products are sub-divided as follows: **Cast Products.**
(Definitions to follow.)

(E) POTTERY PRODUCTS.

Pottery Products.

8. Gypsum pottery products are sub-divided as follows:

(Definitions to follow.)

III. CHEMICAL PRODUCTS.

(A) FERTILIZERS.

Fertilizers.

9. Gypsum fertilizers are sub-divided as follows:

(Definitions to follow.)

(B) PORTLAND-CEMENT MANUFACTURE.

Portland-Cement Manufacture.

10. The uses of gypsum in Portland-cement manufacture may be sub-divided as follows:

(Definitions to follow.)

(C) SULFURIC-ACID MANUFACTURE.

Sulfuric-Acid Manufacture.

11. The uses of gypsum in sulfuric-acid manufacture may be sub-divided as follows:

(Definitions to follow.)

(D) (Title to follow.)

12. The uses of gypsum in (another chemical process) may be sub-divided as follows:

(Definitions to follow.)

IV. PIGMENT PRODUCTS.

(A) COATINGS APPLIED WITH BRUSH.

Coatings Applied with Brush.

13. Liquid gypsum coatings applied with a brush are sub-divided as follows:

(Definitions to follow.)

(B) (Title to follow.)

14. (Another pigment product) are sub-divided as follows:

(Definitions to follow.)

V. FILLER PRODUCTS.

(*A*) PAPER FILLERS.

15. Gypsum paper fillers are sub-divided as follows: **Paper Fillers.**
(Definitions to follow.)

(*B*) CLOTH FILLERS.

16. Gypsum cloth fillers are sub-divided as follows: **Cloth Fillers.**
(Definitions to follow.)

(*C*) (Title to follow.)

17. Gypsum (other fillers) are sub-divided as follows:
(Definitions to follow.)

VI. FLUX PRODUCTS.

(*A*) FOUNDRY-CORE FLUXES.

18. Gypsum foundry-core fluxes are sub-divided as follows: **Foundry-Core Fluxes.**
(Definitions to follow.)

(*B*) (Title to follow.)

19. Gypsum (other fluxes) are sub-divided as follows:
(Definitions to follow.)

VII. (Other) PRODUCTS.

(*A*) (Title to follow.)

20. Gypsum (other products) are sub-divided as follows:
(Definitions to follow.)

(*B*) (Title to follow.)

21. Gypsum (other products) are sub-divided as follows:
(Definitions to follow.)

VIII. CLASSES, TYPES AND FORMS OF CEMENTITIOUS BASE PRODUCTS.

(*A*) COATINGS.

Classes of Coatings. 22. *Classes.*—Gypsum coatings applied in plastic form (plasters and stuccoes) are divided into several classes depending upon the predominating cementitious material, as follows:

(*a*) *Lump-Lime Plaster and Stucco.*

1. *Lump-Lime Plaster.*—A plaster in which the predominating cementitious material is lime putty made by slaking quicklime at the job.
2. *Lump-Lime Stucco.*—A stucco in which the predominating cementitious material is lime putty made by slaking quicklime at the job.

(*b*) *Hydrated-Lime Plaster and Stucco.*

1. *Hydrated-Lime Plaster.*—A plaster in which the predominating cementitious material is hydrated lime. It may be either "job-mixed plaster" or "prepared plaster." (See Section 23.)
2. *Hydrated-Lime Stucco.*—A stucco in which the predominating cementitious material is hydrated lime. It may be either "job-mixed stucco" or "prepared stucco." (See Section 23 (*a*)*2*, or (*b*)*2*.)

(*c*) *Gypsum Plaster and Stucco.*

1. *Gypsum Plaster.*—A plaster in which the predominating cementitious material is calcined gypsum.

   (Frequently called "cement plaster," "hard wall plaster," "patent plaster," "calcined plaster," "rock-wall plaster," "stucco wall plaster," etc. The use of these terms should be avoided.)

2. *Gypsum Stucco.*—A stucco in which the predominating cementitious material is calcined gypsum.

(*d*) *Keene's-Cement Plaster and Stucco.*

1. *Keene's-Cement Plaster.*—A plaster in which the predominating cementitious material is Keene's cement.
2. *Keene's-Cement Stucco.*—A stucco in which the predominating cementitious material is Keene's cement.

(*e*) *Portland-Cement Plaster and Stucco.*

1. *Portland-Cement Plaster.*—A plaster in which the predominating cementitious material is Portland cement.
2. *Portland-Cement Stucco.*—A stucco in which the predominating cementitious material is Portland cement.

(*f*) *Natural-Cement Plaster and Stucco.*

1. *Natural-Cement Plaster.*—A plaster in which the predominating cementitious material is natural cement.
2. *Natural-Cement Stucco.*—A stucco in which the predominating cementitious material is natural cement.

Forms of Coatings.

23. *Forms.*—Plasters and stuccoes are divided into several forms depending upon the amount of mixing done at the mill of the producer as follows:

(*a*) *Job-Mixed Plaster and Stucco.*

1. *Job-Mixed Plaster.*—A plaster in which all the ingredients are mixed at the job.
2. *Job-Mixed Stucco.*—A stucco in which all the ingredients are mixed at the job.

(*b*) *Prepared Plaster and Stucco.*

1. *Prepared Plaster.*—A plastering material mixed at the mill by the producer with all the constituent parts in their proper proportion, with the exception of the aggregate which may or may not be incorporated with the mixture at the mill.

   Prepared plasters are sub-divided into "ready-mixed plasters" and "neat plasters." See definition of these plasters.
2. *Prepared Stucco.*—A stucco material mixed at the mill by the producer with all the constituent parts in their proper proportion, with the exception of the aggregate which may or may not be incorporated with the mixture at the mill.

   Prepared stuccoes are sub-divided into "ready mixed stucco" and "neat stuccoes." See definitions of these stuccoes.

3. *Ready-Mixed Plaster.*—A "prepared plaster" requiring only the addition of water to make it ready for use.

This term distinguishes "ready-mixed plaster" from "neat plaster."

4. *Ready-Mixed Stucco.*—A "prepared stucco" requiring only the addition of water to make it ready for use.

This term distinguishes "ready-mixed stucco" from "neat stucco."

5. *Neat Plaster.*—A "prepared plaster" requiring the addition of both the aggregate and water to make it ready for use.

This term distinguishes "neat plaster" from "ready-mixed plaster."

6. *Neat Stucco.*—A "prepared stucco" requiring the addition of both the aggregate and water to make it ready for use.

This term distinguishes "neat stucco" from "ready-mixed stucco."

Types of Coatings. 24. *Types.*—Plasters and stuccoes are divided into several types depending upon the following conditions:

(*a*) *Material Used as an Aggregate.*

1. *Sand Plaster and Sand Stucco.*

Sand Plaster.—A plaster in which sand is used as the aggregate. This expression is used without regard to either the cementitious material employed, or the place of mixing the ingredients.

This term distinguishes "sand plaster" from "pulp plaster."

Sand Stucco.—A stucco in which sand is used as the aggregate. This expression is used without regard to either the cementitious material employed, or the place of mixing the ingredients.

This term distinguishes "sand stucco" from "pulp stucco."

2. *Pulp Plaster and Pulp Stucco.*

Pulp Plaster.—A plaster in which pulp is used as the aggregate. This expression is used with-

out regard to either the cementitious material employed or the place of mixing the ingredients.

This expression distinguishes "pulp plaster" from "sand plaster."

Pulp Stucco.—A stucco in which pulp is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

This expression distinguishes "pulp stucco" from "sand stucco."

3. *Fiber Plaster and Fiber Stucco.*

Fiber Plaster.—A plaster in which fiber is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

Fiber Stucco.—A stucco in which fiber is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

(*b*) *Number of Coats.*

1. *Two-Coat Work.* (Definition to follow.)
2. *Three-Coat Work.* (Definition to follow.)

First or Scratch Coat.—The first coat of plaster or stucco. It is applied directly to the lath or masonry surfaces to be covered, and is scratched before thoroughly dry to provide a better bond for the next coat.

Second or Browning Coat.—The second coat of plaster or stucco. Generally used only in three-coat work, but does sometimes mean the finishing coat in two-coat work.

(*c*) *Method of Application.*

1. *Dry Scratch Work.* (Definition to follow.)
2. *Doubled-up Work.* (Definition to follow.)
3. *Drawn Work.* (Definition to follow.)

(*d*) *Finish.*—The finish given to a plastered or stuccoed surface is sub-divided as follows:

Finish or White Coat.—The last coat of plaster or stucco. In three-coat work it is applied to

the second coat, and in two-coat work it is applied to the first coat, and then sometimes known as the second coat.

1. *White Troweled or Smooth Finish.* (Definition to follow.)
2. *Sand-Float or Rough Finish.* (Definition to follow.)
3. *Pebble Dash Finish.* (Definition to follow.)
4. *Stippled Finish.* (Definition to follow.)

(*B*) BONDINGS.

Development of Part II (*B*), Section 5. Definitions to follow.

(*C*) STRUCTURAL PRODUCTS.

Development of Part II (*C*), Section 6. Definitions to follow.

(*D*) CAST PRODUCTS.

Development of Part II (*D*), Section 7. Definitions to follow.

(*E*) POTTERY PRODUCTS.

Development of Part II (*E*), Section 8. Definitions to follow.

IX. CLASSES, TYPES AND FORMS OF CHEMICAL PRODUCTS.

Development of Part III, Sections 9–12. Definitions to follow.

X. CLASSES, TYPES AND FORMS OF PIGMENT PRODUCTS.

Development of Part IV, Sections 13–14. Definitions to follow.

XI. CLASSES, TYPES AND FORMS OF FILLER PRODUCTS.

Development of Part V, Sections 15–17. Definitions to follow.

XII. CLASSES, TYPES AND FORMS OF FLUX PRODUCTS.

Development of Part VI, Sections 18–19. Definitions to follow.

XIII. CLASSES, TYPES AND FORMS OF (Other) PRODUCTS.

Development of Part VII, Sections 20-21. Definitions to follow.

XIV. GLOSSARY.

(*A*) DEFINITIONS OF INGREDIENTS OF GYPSUM PRODUCTS.

1. *Gypsum.*—Gypsum is a hydrous calcium sulfate, formula $CaSO_4.2H_2O$, which may contain varying percentages of silica, alumina, iron oxide, and carbonates of calcium and magnesium.

   Limitations as to percentages of impurities should be established.

2. *Uncalcined Gypsum.*—A synonym for gypsum.

   Generally used to mean the raw material as taken from the mine or quarry for commercial use.

3. *Mass Gypsum.*—(Definition to follow.)
4. *Crushed Gypsum.*—A form of uncalcined gypsum. The size (state size limitations), distinguishing it from "ground gypsum."
5. *Ground Gypsum.*—A form of uncalcined gypsum. The size (state size limitations), distinguishing it from "crushed gypsum."
6. *Calcined Gypsum.*—A product resulting from the partial or complete calcination of gypsum. A cementitious material often used in stuccoes, plasters, mortars, concretes, etc., as the active setting material.

   Chemically pure calcined gypsum has the formula $CaSO_4.H_2O$. The commercial material has the same impurities as gypsum; silica, alumina, iron oxide, and carbonates of calcium and magnesium. Limitations as to percentage of impurities should be established. Frequently called "Plaster of Paris," the use of which should be avoided. (See Part XIV, Glossary, Section 29.)

7. *Cement.*—A material or a mixture of materials having cementitious properties (as hydrated lime, Portland cement, calcined gypsum, natural cement, glue, asphalt, Keene's cement, etc.). The word "cement" is used without regard to the composition of the material, and does not define its use or location of use as do the words "stucco," "plaster" and "mortar."

8. *Concrete.*—A mixture of one or more cementitious materials (as Portland cement, hydrated lime, calcined gypsum, natural cement, etc.), with an aggregate of sand, broken stone, cinders, asbestos fiber, etc., which becomes a solid mass when the cementitious materials have hardened.

9. *Portland Cement.*—The product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

Definition taken from Standard Specifications and Tests for Portland Cement (Serial Designation: C 9) of the American Society for Testing Materials.[1]

10. *Natural Cement.*—The finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the caronbic acid gas.

Definition taken from Standard Specifications for Cement (Serial Designation: C 10) of the American Society for Testing Materials.[1]

11. *Keene's Cement.*—(Definition to follow.)

12. *Quicklime.*—A material the major part of which is calcium oxide or calcium and magnesium oxide, which will slake on the addition of water.

Definition taken from Standard Specifications for Quicklime (Serial Designation: C 5) of the American Society for Testing Materials,[1] where it is divided into two forms, "lump" and "pulverized." See definitions of "lump lime" and "pulverized lime."

Also known as "lime," "lump lime," "burned lime," "calcinde lime," the use of which terms should be avoided.

13. *Lump Lime.*—A form of quicklime. The size taken from the kiln without crushing or grinding, distinguishing it from "pulverized lime."

Definition taken from Standard Specifications for Quicklime (Serial Designation: C 5) of the American Society for Testing Materials.[1] The form of quicklime generally slaked at the job to make "lime putty."

14. *Pulverized Lime.*—A form of quicklime; "lump lime" reduced in size to pass a $\frac{1}{4}$-in. screen, distinguishing it from "lump lime."

Definition taken from Standard Specifications for Quicklime

[1] See 1918 Book of A.S.T.M. Standards.

(Serial Designation: C 5) of the American Society for Testing Materials.[1] This form of quicklime is seldom slaked at the job to produce "lime putty."

15. *Hydrated Lime.*—A cementitious material often used in stucco, plaster, mortar, etc., as an active setting agent. Always prepared at the mill of the producer and never made at the job from quicklime.

The definition given in the Standard Specifications for Hydrated Lime (Serial Designation: C 6) of the American Society for Testing Materials[1] is as follows: "A dry flocculent powder resulting from the hydration of quicklime." Analysis required by these specifications permits only the amount of water necessary to satisfy chemical hydration. This makes production of hydrated lime impossible at the job.

16. *Lime Putty.*—The predominating cementitious material in lime plaster, lime stucco and lime mortar. Made by slaking "quicklime" with an excess of water, or by adding water to "hydrated lime." A white, cream-like, smooth plastic paste.

Also called "slaked lime," the use of which term should be avoided.

17. *Lime Paste.*—A synonym of "lime putty."
18. *Aggregate.*—The inert materials used as a filler in stucco, plaster, mortar, concrete mixtures, without regard to their function as a binding material.
19. *Fine Aggregate.*—(Definition to follow.)
20. *Filler.*—A synonym for "aggregate."
21. *Sand.*—(Definition to follow.)
22. *Pulp.*—A binder used in stucco and plaster. Made by grinding, crushing or shredding wood in a manner similar to that in preparing wood pulp in paper manufacture. One of the general classes of fiber binders.
23. *Binder.*—A material used in stucco and plaster to increase the tensile strength, intended to prevent cracking and crumbling.
24. *Fiber.*—A general class of material used as binders in stucco and plaster. May be of wood, asbestos, hemp, etc.
25. *Hair.*—A binder used in stucco. and plaster. Obtained from goats, cattle or other animals. One of the general class of fiber binders.

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[1] See 1918 Book of A.S.T.M. Standards.

26. *Asbestos.*—(Definition to follow.)
27. *Retarders.*—Any material used in stucco, plaster, mortar, concrete, etc., to reduce the rapidity with which the cementitious materials set.
28. *Accelerators.*—Any material used in stucco, plaster, mortar, concrete, etc., to increase the rapidity with which the cementitious materials set.

(*B*) TERMS, THE USE OF WHICH SHOULD BE AVOIDED IF POSSIBLE.

29. *Plaster-of-Paris.*—This term uses "plaster" in a sense not in agreement with the definition. Also, this material is wrongly considered to be plaster, resulting in misunderstandings. "Calcined gypsum" is the term that should be used. (See Part XIV, Glossary, Section 6.)
30. *Cement Plaster.*—The term lacks definiteness, as it has been used to mean both "gypsum plaster" and "Portland-cement plaster."
31. *Hard Wall Plaster.*—See Part XV, Appendix, Section 20.
32. *Rock Wall Plaster.*—See Part XV, Appendix, Section 20.
33. *Patent Plaster.*—See Part XV, Appendix, Section 20.
34. *Calcined Plaster.*—See Part XV, Appendix, Section 20.
35. *Stucco Plaster.*—See Part XV, Appendix, Section 20.
36. *Wall Plaster.*—See Part XV, Appendix, Section 20.
37. *Stucco Wall Plaster.*—See Part XV, Appendix, Section 20.
38. *Ceiling Plaster.*—See Part XV, Appendix, Section 20.
39. *Dry Mortar.*
40. *Bag Mortar.*
41. *Plaster Mortar.*
42. *Stucco Mortar.*
43. *Lime.*—It has been misused to mean any cementitious lime material without regard to its chemical or physical nature, and now lacks specific meaning. Chemically pure lime (CaO) is seldom used in the arts. See definition of "quicklime."
44. *Burned Lime.*—See definition of "quicklime," Part XIV, Glossary, Section 12.
45. *Calcined Lime.*—See definition of "quicklime," Part XIV, Glossary, Section 12.
46. *Slaked Lime.*—See definition of "lime putty" or "lime paste," Part XIV, Glossary, Sections 16 or 17.
47. *Building Lime.*—See definition of "quicklime," "lump lime," "pulverized lime," "hydrated lime," Part XIV, Glossary, Sections 12-15.
48. *Land Plaster.*

APPENDIX.

XV. DEVELOPMENT OF DEFINITIONS.

(*A*) STUCCO.

1. The word "stucco" is derived from the old High German word "stuchhi" meaning "a crust" or "piece." **Stucco.**

2. Webster's Unabridged Dictionary defines the "stucco" as "plaster of any kind used as a coating for walls; especially a fine plaster, composed of lime or gypsum, sand and pounded marble, used for internal decorations and fine work." From this it appears that "stucco" may mean a coating for either exterior or interior walls, with particular reference to interior ornamental work as moldings, cornices, etc.

3. Manufacturers have used the word stucco to mean different materials without regard to the location of the surface to which it is applied. The following shows how "stucco" has been used by various manufacturers.

(*a*) Atlas Wall Plaster Co., Louisville, Ky., produce "Atlas Stucco Finish" for interior finish only, which is a calcined gypsum product.

(*b*) Michigan Gypsum Co., Grand Rapids, Mich., produce "N. P. Brand Stucco" for interior finish only, which is a calcined gypsum product.

(*c*) Plymouth Gypsum Co., Fort Dodge, Iowa, produce "Plymouth Rock Stucco," use not given, but probably for ***exterior*** work; which is a calcined gypsum product.

(*d*) The Associated Metal Lath Manufacturers have defined "stucco" as referring solely to a covering of an exterior wall without regard to the composition of the material.

(*e*) Monument Plaster Co., Harrison, N. J., produce "Oriental Stucco," a material for exterior finish only. This is a lime product.

(*f*) The Association of American Portland Cement Manufacturers have prepared Bulletin No. 22 on Portland-Cement Stucco. In this Bulletin "stucco" is used to mean a covering of an exterior wall only.

4. An examination of other literature in which the word "stucco" is used shows the following:

(*a*) Mr. Edwin C. Eckel, C.E., in his book on "Cements, Limes and Plasters" considers "stucco" as a synonym for Plaster of Paris without definition as to its use in exterior or interior work.

(*b*) Many books describing exterior treatments for buildings by applying coatings of cementitious materials, use the word "stucco" in describing the materials.

(*c*) The paint manufacturers that produce materials for coloring, dampproofing and weatherproofing stucco use the word "stucco" to mean the material used to coat an exterior wall.

(*d*) Among architects, building contractors, and building owners, the word "stucco" has grown to mean an exterior wall covering or coating.

5. Consequently, it is advisable to discontinue the use of the word "stucco" to describe a covering material for an interior surface; since, where the greatest study of the materials for exterior surface covering has been made, "stucco" has been used to differentiate this use of material from all others.

(*B*) PLASTER.

Plaster. 6. The word "plaster" is derived from the Greek and Latin words meaning "to daub on" or "to stuff in."

7. Webster's Unabridged Dictionary defines "plaster" as "a composition of lime, water and sand with or without hair as a bond, for coating walls, ceilings and partitions of houses;" also as "calcined gypsum or plaster of Paris, especially when ground, as used for making ornaments, figures, moldings, etc."

8. For many years, plasters have been divided into two classes, interior and exterior plasters, depending upon the location or exposure of the surface to which the material is applied. Exterior plaster is better defined as "stucco" and should be so called. As a result, the above distinction is not necessary and by elimination, "plaster" means but one thing, namely: a coating for interior surface not exposed to weather.

9. Objection to this limitation in the definition of plaster will perhaps be made by those who use the term "exterior plaster" rather than stucco and the few using "stucco" to mean a special form of material for interior work.

10. It will be noted that the definition of "plaster" proposed in Part II, Section 4 (*a*), does not include uses of the material not given in either the root of the word or in its dictionary definition. The proposed definition merely limits the meaning of the word in order to make it a foundation on which can be built a collection of terms that will accurately describe the many various materials and mixtures used in plastering.

11. This restricted use of the word "plaster" will prevent the present confusion between plasters and the materials used in making plaster, and make clear at once the designed use of the material. Evidence of this confusion is found in the expression "Plaster of Paris," which to many has meant "plaster." The preceding definitions have shown that this material is not plaster, but rather is "calcined gypsum," which it should be called. Other confusing expressions are "stucco wall plaster," and "stucco plaster," which have been used in the past without regard to the location of the use of the material, and mean either interior or exterior wall covering material depending only upon the connection in which they are used or the nature of the product produced by the manufacturer marketing the materials. All these and similar misunderstandings are obviated by using the suggested definitions for "plaster" and "stucco."

(*C*) MORTAR.

12. The word "mortar" is derived from the Latin word "mortarium," meaning a vessel in which substances are pounded or rubbed, and later the pounded or rubbed substances. **Mortar.**

13. Webster's Unabridged Dictionary defines the word as "a building material made by mixing lime, cement or plaster of Paris with sand, water and sometimes other materials; used in masonry for joining stones, bricks, etc., also for plastering and in other ways." From this it appears that "mortar" means the same as that given in preceding paragraphs for stucco, plaster, and mortar.

14. The use of the word "mortar" as given in Part II, Section 5 (*a*), adds no new meaning, but restricts it to a particular use, rendering unnecessary such expressions as "stucco mortar,"

"plaster mortar," etc. It will also remove the confusion resulting from using the same expression to define materials used in making stuccoes, plasters and mortars.

(*D*) PLASTERS AND PLASTERING MATERIALS.

Plasters and Plastering Materials.

15. A careful distinction should be made between plaster and the materials used to make plaster. For instance, hydrated lime may or may not be mixed with sand or other aggregates and a binder to make plaster. In this case, if the plaster is used for scratch or brown coat work, no one individual material is plaster, but the completed mixture is plaster. It is obvious that the aggregate or fiber, even when water is added, does not constitute plaster; consequently the hydrated lime in this case is not justly considered plaster, as it is a part of the mixture in the same manner that the aggregate and binder are parts of the mixture. However, in finishing coat work, if calcined gypsum is not added to gage the mixture, the hydrated lime is plaster.

16. The statements in Section 15 are not contradictory when the definition for "plaster" in Part II, Section 4 (*a*), is carefully considered. Also, this distinction will cause no confusion in practice, as hydrated lime, or even calcined gypsum, is seldom used alone in finishing coat work, the two materials being mixed together to make finishing coat plaster.

17. An examination of literature descriptive of this class of plaster shows a confusing variety of different expressions, all of which are used in naming the same materials used for the same purpose. Some of these terms and the producers using them are as follows:

Cement Plaster is used by:

Plaster Manufacturers' Assoc.	Crown Gypsum Co.
U. S. Gypsum Co.	Plymouth Gypsum Co.
Michigan Gypsum Co.	Manitoba Gypsum Co.
Overland Gypsum Co.	American Cement Plaster Co.
American Gypsum Co.	Rock Plaster Mfg. Co.
Southern Gypsum Co.	J. B. King and Co.
Atlas Wall Plaster Co.	The Alabastine Co.
Texas Cement Co.	Acme Cement Plaster Co.
Arden Plaster Co.	Wotherspoon Plaster Mills, Inc.

18. From this list, which is only representative, it is evident that in the central and western parts of this country "cement plaster" is very generally used to mean "gypsum plaster." Without doubt, many people must think that "gypsum or calcined gypsum" means the same as "cement." This understanding must cause much confusion, as there are a large number of people who consider cement to mean Portland, Rosendale, Keene's, etc., cement.

19. The suggested use of the terms "gypsum plaster" (Part VIII, Section 22 (*c*) *1*) and "cement" (Part XIV, Glossary, Section7) will prevent many misunderstandings.

20. *Hard Wall Plaster*, *Rock Wall Plaster*, *Patent Plaster*, *Calcined Plaster*, *Wall Plaster*, *Stucco Wall Plaster*, etc., are some of the expressions used to mean the material that has been defined as "gypsum plaster." These expressions have not been as generally used as "cement plaster," and of themselves may not have produced misunderstandings, since, with the exception of "stucco wall plaster," they have not been construed to mean other materials than "gypsum plaster." The expression "gypsum plaster" has an advantage over all these terms in that it denotes the particular cementitious material that is used in causing the plaster to harden.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE RECOMMENDED PRACTICE
FOR
LAYING SEWER PIPE.[1]

Serial Designation: C 12 – 17 T.

This recommended practice is issued under the fixed designation C12; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1915; REVISED, 1916, 1917.

I. PREPARING TRENCHES AND FOUNDATIONS FOR PIPE LAYING.

The foundations in the trench should be formed to prevent any subsequent settlement and thereby possibly an excessive pressure and consequent rupture of the pipes.

If the foundation is rock an equalizing bed of concrete or sand well compacted should be placed upon the rock. The thickness of these beds should be not less than 4 in. Pipes should be laid in these beds so that at least the lower third of each pipe is supported its entire length.

If the foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of each pipe and, if necessary to secure a proper bearing for the pipe, a layer of concrete, fine gravel or other suitable material should be placed. The same means of securing a firm foundation should

[1] Criticisms of this Tentative Recommended Practice are solicited and should be directed, preferably before January 1, 1919, to Mr. Rudolph Hering, Chairman of Committee C-4 on Clay and Cement Sewer Pipe, 170 Broadway, New York City.

be adopted in case the excavation has been made deeper than necessary.

If there is no good natural foundation, the pipes should be laid in a concrete cradle supported on a masonry foundation carried to a soil of satisfactory bearing power or supported on a structure designed to carry the weight of pipe and its load to a firm bearing.

Trenches should be kept free from water until the material in the joints and masonry has sufficiently hardened.

To protect pipe lines from unusual stresses all work should preferably be done in open trenches.

Pipe lines should be placed at a sufficient depth below the surface of the street to avoid dangerous pressure or impact. When this is not possible special reinforcement should be provided.

Trenches should be only of sufficient width to provide a free working space on each side of the pipe, preferably of not over one-third of the nominal diameter, and never less than 4 in., according to the size of the pipe and the character of the ground; but in every case there should be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly ram the back-filling around the pipe and to secure tight joints.

II. PIPE LAYING.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot ends point in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert.

It is necessary to use all possible care when shoving the pipes together, so that the joints will not be unnecessarily large.

Sockets should be carefully cleaned before pipes are lowered into tenches. The pipes should be so lowered as to avoid unnecessary handling in the trench.

The pipes should be set firmly according to line and grade, and the joints carefully adjusted and filled with the jointing material.

Joints should be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than $\frac{3}{4}$ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular spaces between the pipes with a suitable calking tool. When cement joints are used, the gasket should first be saturated with neat cement grout. The remainder of the space should then be completely filled with the joining materials.

III. BACKFILLING TRENCHES.

All trenches and excavations should be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be solidly tamped about the pipes up to a level at least 2 ft. above the top of the pipes. This material should be carefully deposited in uniform layers. Unless otherwise permitted, each layer should be carefully and solidly tamped or rammed with proper tools so as not to injure or disturb the pipe line.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravely materials. If this method is used, the first flooding should be applied after the backfilling has been compacted by tamping up to 2 ft. above the top of the pipes, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipes and also to prevent an undue excess of pressure upon them.

Walking or working on the completed sewer, except as may be necessary in tamping or backfilling, should not be permitted until the trench has been backfilled to a height of at least 2 ft. over the top of the pipes.

The filling of the trench should be carried on simultaneously on both sides of the pipes in such a manner that injurious side pressures do not occur.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR FOOTS PERMISSIBLE IN PROPERLY CLARIFIED PURE RAW LINSEED OIL FROM NORTH AMERICAN SEED.[1]

Serial Designation: D 51 – 18 T.

These specifications are issued under the fixed designation D 51; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

I. PERCENTAGE OF FOOTS.

Percentage of Foots.

1. The amount of foots in properly clarified pure raw linseed oil from North American seed, as determined by the test specified below, shall not exceed 2 per cent by volume.

II. METHOD OF DETERMINATION.

Reagents Required.

2. The following reagents are required:

(*a*) Acetone that will pass United States Pharmacopœia specifications.

(*b*) Acid $CaCl_2$ solution, made by saturating with $CaCl_2$ a mixture of 90 parts water and 10 parts concentrated HCl, sp. gr. 1.2, at room temperature.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 129 York St., Brooklyn, N. Y.

Operation. 3. With all materials at a temperature between 70 and 80° F., mix by shaking in a stoppered flask for exactly one minute, 25 cc. of the well-shaken sample of oil, 25 cc. of acetone and 10 cc. of the acid $CaCl_2$ solution. Transfer the mixture to a burrette where settling can take place for 24 hours. The temperature during this period should be between 70 and 80° F.

The volume of the strata lying between the clear calcium-chloride solution and the clear acetone and oil mixture is read in tenths of a cubic centimeter or a fraction thereof. This reading multiplied by four expresses the amount of foots present as percentage by volume of the oil taken.

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PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
SELECTED STRUCTURAL DOUGLAS FIR BRIDGE AND TRESTLE TIMBERS.[1]

Serial Designation: D 23 – 16 T.

These specifications are issued under the fixed designation D 23; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916.

I. DEFINITIONS.

1. The following definitions are used in connection with these specifications: **Definitions.**

(*a*) *Annual Ring.*—Each annual ring is composed of two distinct types of wood structure, namely, the porous, light colored and light weight spring wood formed during the first part of the growing season and the hard, dense and darker colored summer wood formed during the latter part of the growing season.

(*b*) *Summer Wood.*—Summer wood is the hard, dense portion of the annual ring. It is darker in color than the more porous spring wood.

(*c*) *Sound and Tight Knot.*—A sound and tight knot is one which is solid across its face and which is as hard as the wood surrounding it; and is so fixed by growth or position that it will retain its place in the piece.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

(*d*) *Encased Knot.*—An encased knot is one whose growth rings are not intergrown and homogeneous with the growth rings of the piece it is in. The encasement may be partial or complete; if intergrown partially or so fixed by growth or position that it will retain its place in the piece, it shall be considered a sound and tight knot.

(*e*) *Loose Knot.*—A loose knot is one not firmly held in place by growth or position.

(*f*) *Rotten Knot.*—A rotten knot is one not as hard as the wood it is in.

(*g*) *Measurement of Knots.*

In Beams, the diameter of a knot on the narrow or horizontal face shall be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter.

In Columns, the diameter of a knot on any face shall be taken as its projection on a line perpendicular to the edge of the timber.

(*h*) *Diagonal Grain.*—(Including cross and spiral grain). Diagonal grain is grain not parallel with all the edges of the piece.

(*i*) *Dense and Sound Douglas Fir.*—Under this heading two classes of timber are designated: (1) Dense Douglas fir and (2) sound Douglas fir. It is understood that these two terms are descriptive of the quality of the clear wood.

(*j*) *Dense Douglas Fir.*—Dense Douglas fir shall show on either one end or the other an average of at least 6 annual rings per inch or 18 rings in three inches and at least $33\frac{1}{3}$ per cent summer wood, as measured over the third, fourth and fifth inches on a radial line from the pith, for girders not exceeding 20 in. in height, and for columns 16 in. square or less. For larger timbers the inspection shall be made over the central three inches on the longest radial line from the pith to the corner of the piece. Wide-ring material excluded by the above will be accepted provided the amount of summer wood as above measured shall be at least 50 per cent.

In cases where timbers do not contain the pith, and it is impossible to locate it with any degree of accuracy, the same inspection shall be made over three inches on an approximate radial line beginning at the edge nearest the pith.

The radial line chosen shall be representative. In case of disagreement between purchaser and seller as to what is a representative radial line, the average summer wood and number of rings shall be the average of the two radial lines chosen.

(*k*) *Sound Douglas Fir.*—Sound Douglas fir shall include pieces of Douglas fir without any ring or summer wood requirement.

II. GENERAL REQUIREMENTS.

General Requirements.

2. (*a*) The timber shall be only "Dense Douglas Fir" as defined in Section 1 (*j*).

(*b*) The timber shall be well manufactured, square edge and sawed standard size; solid and free from defects such as ring shakes and injurious diagonal grain, loose or rotten knots,

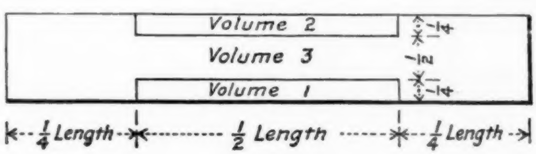

FIG. 1.

knots in groups, decay, pitch pockets over 6 in. long or ⅜ in. wide, or other defects that will materially impair its strength.

(*c*) Occasional variation in sawing, not to exceed ¼ in. scant at the time of manufacture, will be allowed.

(*d*) When timbers 4 by 4 in. and larger are ordered sized, they shall be ½ in. less than rough size, either S1S1E or S4S, unless otherwise specified.

III. STRINGERS, GIRDERS AND DEEP JOISTS.

Stringers, Girders and Deep Joists.

3. The timber shall show not less than 85 per cent of heart on each of the four sides, measured across the sides anywhere in the length of the piece. It shall not have in volumes 1 and 2 (Fig. 1) knots greater in diameter than one-fourth the width of the face in which they occur with a maximum of 1½ in. in diameter. It shall not have in volume 3 (Fig. 1) knots larger than one-third the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots within the center half

of the span shall not exceed in the aggregate the width of the face in which they occur. Diagonal grain in volumes 1 or 2 with a slope greater than 1 in 20 will not be permitted. When stringers are of two-span length they shall be considered as two separate pieces and the above restrictions applied to each half. The inspector shall place his stamp on the edge of the stringer to be placed "up" in service.

IV. CAPS AND SILLS.

Caps and Sills.

4. The timber shall show 85 per cent of heart on each of the four sides, measured across the sides anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

V. POSTS.

Posts.

5. The timber shall show not less than 85 per cent of heart on each of the four sides, measured across the face anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

VI. LONGITUDINAL STRUTS OR GIRTS.

Longitudinal Struts or Girts.

6. The timber shall show all heart on one face; the other face and two sides shall show not less than 85 per cent of heart, measured across the face or side anywhere in the length of the piece, and shall be free from knots over 2 in. in diameter.

VII. LONGITUDINAL X-BRACES, SASH BRACES AND SWAY BRACES.

Longitudinal X-Braces, Sash Braces and Sway Braces.

7. The timber shall show not less than 85 per cent of heart on two faces and shall be free from knots larger than one-third the width of the face in which they occur, with a maximum of 2 in. in diameter.

VIII. BRANDING.

Branding.

8. The inspector shall brand each timber which conforms to the above requirements "Selected Structural Douglas Fir."

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR SOUTHERN YELLOW-PINE TIMBER TO BE CREOSOTED.[1]

Serial Designation: D 24 - 15 T.

These specifications are issued under the fixed designation D 24; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1915.

General Requirements. 1. The specifications as to strength shall agree with the requirements that will be finally adopted by the Society under the Standard Definitions of Terms Relating to Structural Timber (Serial Designation: D 9);[2] that is, number of rings per inch or some substitute therefor.

(Included in this section will also be a list of the allowable defects, etc.)

Sapwood. 2. All pieces shall show at least 30 per cent sapwood in cross-section. This is based on a minimum treatment of 12 lb. of creosote per cubic foot of timber.

Bridge Stringers. 3. In bridge stringers knots greater than 1½ in. in diameter shall be at least 4 in. from the edges of the stick. There shall be no knots more than 4 in. in greatest diameter in any part of the stick.

Caps and Sills. 4. Caps, sills, posts and sawed poles shall be free from knots more than 2½ in. in diameter.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

[2] See 1918 Book of A.S.T.M. Standards.

Bracing. 5. Longitudinal bracing, cross-arms and similar pieces having small cross-section shall have no knots more than 1 in. in diameter.

Track Ties. 6. Track ties shall show at least 20 per cent sapwood in cross-section. This is based on a minimum full-cell treatment of 8 lb. of creosote per cubic foot of timber.

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TENTATIVE SPECIFICATIONS FOR SOUTHERN YELLOW-PINE PILES AND POLES TO BE CREOSOTED.[1]

Serial Designation: D 25 - 15 T.

These specifications are issued under the fixed designation D 25; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1915.

General Requirements. 1. The specifications as to strength shall agree with the requirements that will be finally adopted by the Society under the Standard Definitions of Terms Relating to Structural Timber (Serial Designation: D 9);[2] that is, number of rings per inch or some substitute therefor.

(Included in this section will also be a list of the allowable defects, etc.)

Sapwood. 2. All piles or telegraph poles shall show 40 per cent sapwood in cross-section, or there shall be a ring of sapwood not less than 1 in. in thickness all around the heartwood.

Quality. 3. (*a*) Piles and poles shall be cut from sound live trees, of straight grain and regular taper; without crooks exceeding one-fourth the diameter of the stick at middle of crook when peeled. They shall be free from rot, red heart, holes or rotten knots, shakes and felling checks.

(*b*) All piles and poles shall have the bark and inner skin

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[2] See 1918 Book of A.S.T.M. Standards.

carefully removed when the tree is felled; all limbs and knots trimmed flush and butts cut square

Minimum Diameter. 4. The minimum diameter of piles after peeling shall be as follows:

Length.	Butts, in.	Tops, in.
36 ft. and under	14	10
38 ft. and under 50 ft	14	9
50 ft. and over	15	9

No pile with butt diameter over 18 in., nor top diameter over $13\frac{1}{2}$ in., will be accepted. The length of each pile is to be legibly marked on the butt with white or black paint.

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TENTATIVE SPECIFICATIONS FOR WOODEN PAVING BLOCKS FOR EXPOSED PAVEMENTS.[1]

Serial Designation: D 52-18 T.

These specifications are issued under the fixed designation D 52; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover wooden paving blocks for pavements exposed to alternate wet and dry conditions, as distinguished from pavements which are used under cover and protected from atmospheric influences.

I. TIMBER.

Kind of Timber. 2. The wood, which shall be treated, shall be Southern yellow pine, Douglas fir, tamarack, Norway pine, hemlock, or black gum. Only one kind of wood shall be used in any one contract. The blocks shall be sound, and shall be well manufactured, square-butted, square-edged, free from unsound, loose or hollow knots, knot holes, worm holes, and other defects such as shakes, checks, etc., that would be detrimental to the blocks.

Quality of Timber. 3. The number of annual rings in the one inch which begins two inches from the pith of the block shall not be less than six, measured radially; provided, however, that blocks

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably, before January 1, 1919, to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

containing between five and six rings in this inch shall be accepted if they contain $33\frac{1}{3}$ per cent or more summerwood. In case the block does not contain the pith, the one inch to be used shall begin one inch away from the ring which is nearest to the heart of the block. The blocks in each charge shall contain an average of at least 70 per cent of heart wood. No one block shall be accepted that contains less than 50 per cent of heart wood.

Size of Blocks. 4. The blocks shall be from 5 to 10 in. long, but should preferably average two times the depth; they shall be .... in. in depth.[1] They may be from 3 to 4 in. in width, but in any one city block all of them shall be of uniform width. A variation of $\frac{1}{16}$ in. shall be allowed in the depth and $\frac{1}{8}$ in. in the width of the blocks from that specified. In all cases the width shall be greater or less than the depth by at least $\frac{1}{4}$ in.

II. TREATMENT.

Treatment. 5. The timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed. Green timber and seasoned timber shall not, however, be treated together in the same charge. The blocks shall be treated in an air-tight cylinder with the preservative specified by the purchaser. In all cases, whether thoroughly air-seasoned or green, they shall first be subjected to live steam at a temperature between 220 and 240° F.[2] for not less than 2 hours nor more than 4 hours, at the discretion of the treating plant operator, after which they shall be subjected to a vacuum of not less than 22 in. held for at least one hour. While the vacuum is still on, the preservative oil, heated to a temperature of between 180 and 220° F., shall be run in until the cylinder is completely filled, care being taken that no air is admitted. Pressure shall then be gradually applied not to exceed 50 lb. at the end of the first hour nor 100 lb. at the end of the second hour, and then maintained at not less than 100 lb. nor more than 150 lb. until the wood has absorbed the required amount of oil.[3]

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[1] It is recommended that blocks 4 in. in depth be used for streets with very heavy traffic, and blocks $3\frac{1}{2}$ in. in depth for streets with moderate traffic. For streets with light traffic blocks 3 in. in depth may be used, but where 3-in. blocks are used no block shall be longer than 8 in.

[2] In no case shall a steam pressure of 20 lb. per sq. in. be exceeded.

[3] This treatment is recommended for yellow pine only. It is probably also suited to Norway pine, hemlock, black gum and tamarack, but not to Douglas fir. Further recommendations on the treatment of these species are reserved for the future.

After this a supplemental vacuum, in which the maximum intensity reached is at least 20 in. and the time the vacuum is applied not less than 30 minutes, shall be applied. If desired, this vacuum may be followed by a short steaming period.

Penetration of Preservative.

6. In any charge blocks shall contain at least 16 lb. of water-free oil per cubic foot of wood at the completion of the treatment. The blocks after treatment shall show satisfactory penetration of the preservative, and in all cases the oil shall be diffused throughout the sap wood. To determine this, at least 25 blocks shall be selected from various parts of each charge and sawed in half perpendicular to the fibers through the center, and if more than one of these blocks show untreated sap wood, the charge shall be re-treated. After re-treating, the charge shall be again subjected to a similar inspection.

Handling Blocks After Treatment.

7. Blocks shall preferably be laid in the street as soon as possible after being treated. If they cannot be laid immediately, provision shall be made to prevent them from drying out by stacking in close piles and covering them, and, if possible, by sprinkling them thoroughly at intervals. In any case, where they are not laid as soon as they are received on the street, they shall be well sprinkled about two days before being laid, under the direction of the purchaser. It is important to have the wood sufficiently wet to be swelled to its maximum size before it is laid.

III. PRESERVATIVE.

Preservatives.

8. The preservative used shall be coal-tar paving oil or distillate oil, as specified by the purchaser.

Coal-Tar Paving Oil.

9. The coal-tar paving oil shall be a coal-tar product, of which at least 65 per cent shall be a distillate of coal-gas tar or coke-oven tar and the remainder shall be refined or filtered coal-gas tar or coke-oven tar.

It shall conform to the following requirements:

(*a*) It shall not contain more than 3 per cent of water.

(*b*) It shall not contain more than 3 per cent of matter insoluble in benzol.

(*c*) The specific gravity of the oil at 38° C. shall not be less than 1.07 nor more than 1.14.

(*d*) The distillates, based on water-free oil, shall be within the following limits:

Up to 210° C.	not more than	5	per cent.
" " 235° C.	" " "	25	"

The residue above 355° C., if it exceeds 35 per cent, shall have a float test of not more than 80 seconds at 70° C.

(*e*) The specific gravity of the fraction between 235 and 315° C. shall not be less than 1.03 at 38°/15°.5 C.

The specific gravity of the fraction between 315 and 355° C. shall not be less than 1.09 at 38°/15°.5 C.

(*f*) The oil shall yield not more than 10 per cent coke residue.

Distillate Oil. 10. The distillate oil shall be a distillate of coal-gas tar or coke-oven tar.

It shall conform to the following requirements:

(*a*) It shall not contain more than 3 per cent of water.

(*b*) It shall not contain more than 0.5 per cent of matter insoluble in benzol.

(*c*) The specific gravity of the oil at 38° C. shall not be less than 1.06.

(*d*) The distillates, based on water-free oil, shall be within the following limits:

Up to 210° C.	not more than	5	per cent.
" " 235° C.	" " "	15	"

The residue above 355° C., if it exceeds 10 per cent, shall have a float test of not more than 50 seconds at 70° C.

(*e*) The specific gravity of the fraction between 235 and 315° C. shall not be less than 1.03 at 38°/15°.5 C.

The specific gravity of the fraction between 315 and 355° C. shall not be less than 1.09 at 38°/15°.5 C.

(*f*) The oil shall yield not more than 2 per cent coke residue.

IV. INSPECTION.

Inspection at Plant. 11. All material herein specified and processes used in the manufacture of the blocks therefrom shall be subject to inspection, acceptance, or rejection at the plant of the manufacturer, which shall be equipped with all the necessary gages, appliances,

and facilities to enable the inspector to satisfy himself that the requirements of the specifications are being fulfilled.

Inspection at Street.

12. The purchaser shall have the further right to inspect the blocks after delivery upon the street, for the purpose of rejecting any blocks that do not meet these specifications; except that the plant inspections shall be final with respect to the kind of wood, number of rings per inch, oil, and treatment.

NOTE.

The following specifications for water-gas tar are presented for information:

SPECIFICATIONS FOR WATER-GAS TAR.

The preservative shall be a refined water-gas tar. It shall comply with the following requirements:

1. It shall contain not more than 3 per cent of water.
2. It shall contain not more than 2 per cent of matter insoluble in benzol and chloroform.
3. The specific gravity of the preservative at 38°/15°.5 C. shall not be less than 1.110 nor more than 1.140.
4. The distillates, based on water-free oil, shall be within the following limits:

Up to 210° C.	not more than	5	per cent.
" " 235° C.	" " "	15	"
" " 315° C.	" " "	40	"
" " 355° C.	" less "	25	"

5. The specific gravity of the total distillate below 355° C. shall not be less than 0.99, nor more than 1.03 at 38°/15°.5 C.

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TENTATIVE SPECIFICATIONS
FOR
ASPHALT FOR USE IN DAMP-PROOFING AND WATERPROOFING.[1]

Serial Designation: D 40 – 17 T.

These specifications are issued under the fixed designation D 40; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Material Covered.

1. These specifications cover asphalt for use in damp-proofing and waterproofing, designated as type A, recommended for use under uniformly moderate temperature conditions.

I. PROPERTIES.

Melting Point.

2. The melting point shall be between 38 and 60° C. (100 and 140° F.) as determined by the ring-and-ball method in water bath, and shall be specified for one of the following classes: 54.5 to 60° C. (130 – 140° F.); 46 to 54°.5 C. (115 – 130° F.); 38 to 46° C. (100 – 115° F.). The Tentative Method for Determination of Softening Point of Bituminous Materials other than Tar Products (D 36–16 T) of the American Society for Testing Materials shall be used.

Penetration.

3. The penetration at 25° C. (77° F.) under load of 100 g.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Leroy M. Law, Secretary of Committee D-8 on Waterproofing, Interocean Oil Co., East Brooklyn, Baltimore, Md.

for 5 seconds, as determined by the Standard Test for Penetration of Bituminous Materials (D 5)[1] of the American Society for Testing Materials, shall be not less than 50 nor more than 125.

The penetration shall bear the following relation to the melting point:

Penetration of 50 to 75 for melting points between 54.5 and 60° C. (130 and 140° F.).

Penetration of 75 to 100 for melting points between 46 and 54°.5 C. (115 and 130° F.).

Penetration of 100 to 125 for melting points between 38 and 46° C. (100 and 115° F.).

4. The ductility[2] at 25° C. (77° F.), when a briquette of the material having a minimum cross-section of 1 sq. cm. is pulled apart at the rate of 5 cm. per minute, shall not be less that 30 cm. **Ductility.**

5. The specific gravity shall not be more than 1.08 at 25/25° C. (77/77° F.). **Specific Gravity.**

6. The bitumen soluble in cold carbon bisulfide, as determined by the method in Section 10, shall not be less than 95 per cent. **Soluble in Carbon Bisulfide.**

7. The loss of a 50-g. sample on heating at 163° C. (325° F.) for 5 hours, as determined by the Standard Test for Loss on Heating of Oil and Asphaltic Compounds (D 6)[3] of the American Society for Testing Materials, shall not exceed 1 per cent. The penetration of the residue from this test shall be not less than 50 per cent of the original penetration specified in Section 3. **Loss on Heating.**

8. The ash, as determined by the method in Section 10, shall not exceed 4 per cent. **Ash**

II. METHODS OF TESTING.

9. *Specific Gravity.*—The specific gravity may be determined by any approved method, but some method similar to the following is recommended:

[1] 1918 Book of A.S.T.M. Standards.

[2] A detailed description of the mold and method to be followed is given in Appendix IV, Report of Committee D-4 on Road Materials, *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 349 (1915).

[3] 1918 Book of A.S.T.M. Standards.

Weigh accurately in air a small platinum pan or crucible supported in a wire sling and suspended by a fine platinum wire or silk thread; record the weight as weight *A*. Then weigh it in a like manner completely immersed in freshly distilled water at 25° C. (77° F.) except for the fine platinum wire or silk thread. Record this weight as weight *B*. Then bring the crucible to red heat, cool and almost fill with asphalt which has been melted at the lowest possible temperature. Cool the crucible and contents to room temperature, place in the sling and weigh in air. Record the weight as weight *C*. Then weigh crucible and contents at 25° C. (77° F.) suspended as before in water, and record this weight as weight *D*. From these four weights the specific gravity may be calculated from the following formula:

$$\text{Specific Gravity} = \frac{C-A}{(C-A)-(D-B)}.$$

10. *Bitumen Soluble in Cold Carbon Bisulfide; Ash.*—For this test weigh accurately 1 to 2 g. of asphalt into an Erlenmeyer flask. Pour 100 cc. of c. p. carbon bisulfide into the flask in small portions, with continual agitation, until all lumps disappear and nothing adheres to the bottom. Cork the flask and set aside for 15 minutes. Then filter the solution by suction through an asbestos pad in a Gooch crucible (the best size of crucible for this test is 4.4 cm. wide at the tod tapering to 3.6 cm. at the bottom, and 2.5 cm. deep), which has been previously prepared and weighed. Care shall be exercised in decanting the liquid portion. Stop the decantation at the first sign of sediment coming out. Wash the sides of the flask with a small amount of fresh carbon bisulfide and bring the sediment upon the felt, using a "policeman," if necessary, to remove all adhering material. Then wash the material on the mat with carbon bisulfide until the washings are colorless and continue suction until the odor of carbon bisulfide is hardly detectable. Then clean the outside of the crucible with a cloth moistened with a small amount of solvent. Dry the crucible with contents for one-half hour at 105° C. (221° F.), cool in a desiccator and weigh.

The total weight of insoluble material includes both organic and inorganic insoluble. If organic insoluble material is present, heat the crucible to red heat until no carbonaceous particles remain,—leaving only the mineral ash,—cool and weigh. The percentage soluble in carbon bisulfide, the organic insoluble, if there is any present, and the ash should total 100 per cent. Each should be reported.

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TENTATIVE SPECIFICATIONS
FOR
PRIMER FOR USE WITH ASPHALT FOR USE IN DAMP-PROOFING AND WATERPROOFING.[1]

Serial Designation: D 41 – 17 T.

These specifications are issued under the fixed designation D 41; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Material Covered. 1. These specifications cover primer for use, when specified, with asphalt for use in damp-proofing and waterproofing.

Primer. 2. The primer shall consist of an asphaltic base, complying in every respect with the Tentative Specifications for Asphalt for Use in Damp-proofing and Waterproofing (Type A) for use below grade, which shall be thinned to ordinary paint consistency with a petroleum distillate having an end point on distillation not above 260° C. (500° F.). Not more than 20 per cent of this petroleum distillate shall distill under 120° C. (248° F.).

The distillation shall be carried out according to the Standard Tests for Paint Thinners other than Turpentine (D 28)[2] of the American Society for Testing Materials.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Leroy M. Law, Secretary of Committee D-8 on Waterproofing, Interocean Oil Co., East Brooklyn, Baltimore, Md.

[2] 1918 Book of A.S.T.M. Standards.

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TENTATIVE SPECIFICATIONS FOR COAL-TAR PITCH FOR USE IN DAMP-PROOFING AND WATERPROOFING.[1]

Serial Designation: D 42 – 17 T.

These specifications are issued under the fixed designation D 42; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Material Covered. 1. These specifications cover coal-tar pitch for use in damp-proofing and waterproofing, designated as type A, recommended for use under uniformly moderate temperature conditions.

I. PROPERTIES.

Melting Point. 2. The melting point, as determined by the cube method in water bath, Section 9, shall be between 49 and 60° C. (120 and 140° F.). In specifying the melting point desired within the above limits, a variation of not more than 2°.5 C. (5° F.) in either direction will be permitted.

Penetration 3. The penetration at 25° C. (77° F.) under load of 100 g. for 5 seconds, as determined by the Standard Test for Penetration of Bituminous Materials (D 6)[2] of the American Society for Testing Materials, shall not be less than 20 nor more than 120.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Leroy M. Law, Secretary of Committee D-8 on Waterproofing, Interocean Oil Co., East Brooklyn, Baltimore, Md.

[2] 1918 Book of A.S.T.M. Standards.

Ductility. 4. The ductility[1] at 25° C. (77° F.). when a briquette of the material having a minimum section of 1 sq. cm. is pulled apart at the rate of 5 cm. per minute, shall not be less than 40 cm.

Loss on Heating. 5. The loss of a 20-g. sample on heating at 163° C. (325° F.) for 5 hours, as determined by the Standard Test for Loss on Heating of Oil and Asphaltic Compounds (D 6)[2] of the American Society for Testing Materials, on pitch of melting point between 49 and 54°.5 C. (120 and 130° F.) shall not exceed 9 per cent and on pitch of melting point between 54.5 and 60° C. (130 and 140° F.) shall not exceed 7 per cent.

Specific Gravity. 6. The specific gravity of the pitch at 25/25° C. (77/77° F.) shall not exceed the limits 1.24 and 1.34.

The specific gravity at 60/60° C. (140/140° F.) of the distillate to 355° C. (671° F.) shall not be less than 1.06.

Soluble Matter. 7. The matter soluble in hot toluol-benzol, as determined by the method in Section 12, shall not be less than 65 nor more than 85 per cent.

Ash. 8. The ash, as determined by the method in Section 13, shall not exceed 1 per cent.

II. METHODS OF TESTING.

9. *Melting Point.*—The melting point shall be the temperature at which the pitch formed in a ½-in. cube and suspended in a vessel of water 1 in. above the bottom shall touch the bottom of this vessel. The cube is formed by pressing the pitch in a suitable mold. Remove the cube from the mold and suspend on the lower arm of a No. 12 B. & S. gage wire bent at right angles. The wire should be passed through the center of two opposite faces of the cube. Immerse the cube in 400 cc. of freshly boiled distilled water at a temperature of 15°.5 C. (60° F.) contained in a 600-cc. beaker. Maintain this temperature until the pitch is the same temperature as the water. Apply heat in such a manner that the temperature of the water is raised 5° C. (9° F.) per minute, until the pitch touches the bottom of the beaker. At this point the temperature, recorded

[1] A detailed description of the mold and method to be followed is given in Appendix IV, Report of Committee D-4 on Road Materials, *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 349 (1915).

[2] 1918 Book of A.S.T.M. Standards; use a 20-g. sample instead of the 50-g. sample specified.

by a thermometer whose bulb shall be level with the cube, shall be considered as the melting point of the pitch.

10. *Specific Gravity.*—The specific gravity may be determined by any approved method, but some method similar to the following is recommended:

Weigh accurately in air a small platinum pan or crucible supported in a wire sling and suspended by a fine platinum wire or silk thread; record the weight as weight A. Then weigh it in a like manner completely immersed in freshly distilled water at 25° C. (77° F.), except for the fine platinum wire or silk thread. Record this weight as weight B. Then bring the crucible to red heat, cool and almost fill with pitch which has been melted at the lowest possible temperature. Cool the crucible and contents to room temperature, place in the sling and weigh in air. Record the weight as weight C. Then weigh crucible and contents at 25° C. (77° F.) suspended as before in water, and record this weight as weight D. From these four weights the specific gravity may be calculated from the following formula:

$$\text{Specific Gravity} = \frac{C-A}{(C-A)-(D-B)}.$$

11. *Specific Gravity of Distillate.*—Distill in a glass or metal retort, preferably of 8-oz. capacity, at least 100 g. of the pitch to 355° C. (671° F.) vapor temperature, catching the distillate. The specific gravity may be determined by any approved method, but the following is recommended:

Clean a 10-cc. specific-gravity bottle; dry and weigh. Fill it with distilled water and heat to 60° C. (140° F.) as described below; dry and weigh. Then fill the bottle with distillate, immerse in water and heat slowly to 60° C. (140° F.), maintaining this temperature for at least 5 minutes. Dry, cool and weigh. From these weights the specific gravity may be determined from the following formula:

$$\text{Specific Gravity} = \frac{\text{Weight of bottle} + \text{distillate} - \text{weight of bottle.}}{\text{Weight of bottle} + \text{water} - \text{weight of bottle}}$$

12. *Matter Insoluble in Hot Toluol-Benzol Extraction.*[1]—In

[1] A full description of a simple apparatus for this test may be found in the *Journal of Industrial and Engineering Chemistry*, Vol. 6, pp. 279–285.

testing materials of 5 per cent or more insoluble matter 5 g. should be taken for the test. With lesser percentages 10 g. should be used. Weigh out the amount in a 100-cc. beaker, and digest with about 50 cc. of c. p. toluol on the steam bath, for a period not to exceed 30 minutes. If the solution is kept hot and constantly stirred, the digestion can be completed very rapidly. Weigh a filter cup, previously prepared, in a weighing bottle and place in a carbon filter tube over a beaker or flask. Decant the toluol-tar mixture through the thimble and wash with hot c. p. toluol until clean, using some form of "policeman" which is unaffected by toluol, for the purpose of detaching any residue which may adhere to the beaker. Finally, wash the cup with hot c. p. benzol and then, after draining, cover with a cap of filter paper or alundum, and place in the extraction apparatus in which the c. p. benzol is used as solvent. Continue the extraction until the descending benzol is colorless. Remove the thimble, take off the cap, dry in the steam oven and weigh in the weighing bottle after cooling in the desiccator. The balance used for this work should be accurate to at least $\frac{1}{2}$ mg. It is well to examine the insoluble residue for foreign matter such as wood, slivers, pieces of bagging, etc. If such foreign matter is present, the test should be rejected.

13. *Ash.*—This determination is made by burning to ash a 1-g. sample of the material in a weighed platinum crucible or dish of sufficient size. Apply heat gently until the pitch ignites, then withdraw the heat. After the pitch ceases to burn, apply the heat again until the residue is burned free of carbon. Then cool the crucible and contents, weigh, and determine the ash.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR CREOSOTE OIL FOR PRIMING COAT WITH COAL-TAR PITCH FOR USE IN DAMP-PROOFING AND WATERPROOFING.[1]

Serial Designation: D 43 – 17 T.

These specifications are issued under the fixed designation D 43; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Material Covered. 1. When it is specified that previous to the mopping on of the hot coal-tar pitch, the wall, floor, or foundation shall be painted with a priming coat, the following specifications for creosote oil shall apply:

Definition. 2. Creosote oil shall be a pure tar distillate free from any substance foreign to a tar distillate.

Melting Point. 3. The oil shall be entirely fluid at 38° C. (100° F.).

Specific Gravity. 4. The specific gravity at 38° C. (100° F.) shall not be less than 1.00 nor more than 1.06.

Insoluble Matter. 5. Insoluble matter in hot benzol shall be less than 1 per cent.

Distillation. 6. When distilled in accordance with the Standard Methods

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. Leroy M. Law, Secretary of Committee D-8 on Waterproofing, Interocean Oil Co., East Brooklyn, Baltimore, Md.

for Sampling and Analysis of Creosote Oil (D 38)[1] of the American Society for Testing Materials, it shall yield:

(*a*) Water, not more than 2 per cent.

(*b*) Not more than 5 per cent shall distill under 200° C. (392° F.).

(*c*) Not more than 50 nor less than 30 per cent shall distill under 235° C. (455° F.).

(*d*) The residue above 355° C. (671° F.) shall not exceed 15 per cent.

(*e*) The residue shall be soft.

(*f*) The specific gravity at 38° C. (100° F.) of the fraction distilling between 235 and 315° C. (455 and 599° F.) shall not be less than 1.00.

[1] 1918 Book of A.S.T.M. Standards.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR CANNED FOODS BOXES, NAILED AND LOCK-CORNER CONSTRUCTION.[1]

Serial Designation: D 44 – 17 T.

These specifications are issued under the fixed designation D 44; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

I. MANUFACTURE.

1. Boxes shall be well manufactured from sound (free from decay or dote), well-seasoned lumber. Boxes when stored after nailing should not be placed in a heated room. Lumber shall be free from knot holes, loose or rotten knots greater than 1 in. in diameter. No knots will be permitted which will interfere with the proper nailing of the box. **Manufacture.**

2. Cleats shall be $1\frac{1}{8}$ by $\frac{3}{8}$ in., or any other size that has equally large cross section, with six nails to each cleat driven through and clinched. No piece of end shall have less than two nails. The outside nails shall be driven as near the ends of cleats as possible without splitting the cleat; the remainder of the nails shall be as evenly spaced as possible. No nail shall be driven in a joint. **Cleating.**

3. Nails shall be as evenly spaced as possible, and no nail **Nailing.**

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. W. S. Topping, Secretary of Committee D-10 on Shipping Containers, 30 Vesey St., New York City.

shall be driven in a joint. All nails shall be driven squarely into the center of the thickness of the end. There shall be at least two nails in each end of any one piece of lumber.

Outside nails on the sides shall be driven just inside the end nails of the cleats.

Outside nails on the top and bottom shall be driven far enough inside to miss the side nails.

The sides, tops and bottoms shall be flush with the ends.

The tops and bottoms shall overlap the sides.

The size of nails shall depend on the woods used for the ends.

II. DIVISION BY SPECIES OF WOOD.

(*A*) *Group I.*[1]

Group I.

4 Group I shall comprise the following species of wood:

White pine	Willow
Aspen	Noble fir
Western yellow pine	Magnolia
Spruce	Buckeye
Cottonwood	White fir
Yellow poplar	Cedar
Balsam fir	Redwood
Chestnut	Butternut
Sugar pine	Cucumber
Basswood	Alpine fir
Cypress	Lodgepole pine

Nos. $2\frac{1}{2}$ and 3 Cans, Group I.

5. Boxes for two dozen No. $2\frac{1}{2}$, two dozen No. 3, and two dozen extra size No. 3 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{5}{8}$ in. thick, and of one or two pieces. Two-piece ends shall be cleated or fastened with three 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain. When one-piece sides are used the third corrugated fastener may be omitted.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

[1] When one-piece sides and two-piece tops and bottoms of sawed lumber are used, material $\frac{1}{16}$ in. thinner will be permitted. The thicknesses specified herein are to allow for an occasional unavoidable variation in manufacture, but that variation shall not exceed $\frac{1}{32}$ in. below the thicknesses specified.

There shall be seven *6d* standard, cement-coated box nails, not less than $1\frac{13}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{5}{8}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued. The top and bottom shall be nailed with not less than fourteen *6d* standard, cement-coated box nails in each top and each bottom.

Nos. 1 and 2 Cans, Group I.

6. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{5}{8}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with two 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be seven *6d* standard, cement-coated box nails, not less than $1\frac{13}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construcuion*—The ends shall be $\frac{5}{8}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued. The top and bottom shall be nailed with not less than fourteen *6d* standard, cement-coated box nails in each top and each bottom.

Nos. 1 and 2 Cans, Group I.

7. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{5}{8}$ in. thick, and of one or two pieces. Two-piece ends shall be cleated or fastened with two 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be six *6d* standard, cement-coated box nails, not less than $1\frac{13}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends and sides shall be at least $\frac{7}{16}$ in. thick, and the top and bottom $\frac{5}{16}$ in. thick; or $\frac{1}{2}$-in. ends may be used with $\frac{5}{16}$-in. sides, top and bottom. All

piecing shall be tongued, grooved and glued, and the top and bottom shall be nailed with not less than twelve 4*d* standard, cement-coated box nails in each top and each bottom.

(*B*) *Group II.*[1]

Group II. 8 Group II shall comprise the following species of wood:

Southern yellow pine	Douglas fir
Hemlock	Larch
Virginia and Carolina pine	

Nos. 2½ and 3 Cans, Group II. 9. Boxes for two dozen No. 2½, two dozen No. 3, and two dozen extra size No. 3 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{5}{8}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with three 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain. When one-piece sides are used, the third corrugated fastener may be omitted.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be seven 5*d* standard cement-coated, box nails, not less than $1\frac{9}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{5}{8}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued, and nailed with not less than fourteen 5*d* standard, cement-coated box nails in each top and each bottom.

Nos. 1 and 2 Cans, Group II. 10. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{5}{8}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with two 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three

[1] When one-piece sides and two-piece tops and bottoms of sawed lumber are used, material $\frac{1}{32}$ in. thinner will be permitted. The thicknesses specified herein are to allow for an occasional unavoidable variation in manufacture, but that variation shall not exceed $\frac{1}{32}$ in. below the thicknesses specified.

pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be six 5*d* standard, cement-coated box nails, not less than $1\frac{9}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends and sides shall be at least $\frac{7}{16}$-in. thick and the top and bottom $\frac{5}{16}$ in. thick; or $\frac{1}{2}$-in. ends may be used with $\frac{5}{16}$-in. sides, top and bottom. All piecing shall be tongued, grooved and glued and the top and bottom nailed with not less than twelve 4*d* standard, cement-coated box nails in each top and each bottom.

(*C*) *Group III.*[1]

11. Group III shall comprise the following species of wood: **Group III.**

White elm	Black ash
Red gum	Black gum
Sycamore	Tupelo
Pumpkin ash	Maple, soft or silver

12. Boxes for two dozen No. $2\frac{1}{2}$, two dozen No 3, and two dozen extra size No. 3 cans shall be constructed as follows: **Nos. $2\frac{1}{2}$ and 3 Cans, Group III.**

(*a*) *Nailed Construction.*—The ends shall be $\frac{1}{2}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with three 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain. When one-piece sides are used, the third corrugated fastener may be omitted.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

A veneer of Red gum $\frac{1}{4}$ in. thick shall be used with one-piece sides and tops, and one and two-piece bottoms. No piece shall be less than 2 in. in width.

There shall be seven 4*d* standard, cement-coated box nails, not less than $1\frac{5}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{1}{2}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing

[1] When one-piece sides and two-piece tops and bottoms of sawed lumber are used, material $\frac{1}{32}$ in. thinner will be permitted. The thicknesses specified herein are to allow for an occasional unavoidable variation in manufacture, but that variation shall not exceed $\frac{1}{32}$ in. below the thicknesses specified.

shall be tongued, grooved and glued, and the top and bottom nailed with not less than fourteen 4*d* standard, cement-coated box nails in each top and each bottom.

Nos. 1 and 2 Cans, Group III. 13. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{1}{2}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with two 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain.

The sides, tops and bottoms shall be of sawed lumber $\frac{5}{16}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

A veneer of Red gum $\frac{1}{4}$ in. thick shall be used with one-piece sides and tops, and one and two-piece bottoms. No piece shall be less than 2 in. in width.

There shall be six 4*d* standard, cement-coated box nails, not less than $1\frac{5}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{1}{2}$ in. thick, and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued and the top and bottom shall be nailed with not less than twelve 4*d* standard, cement-coated box nails in each top and each bottom.

(*D*) *Group IV.*

Group IV. 14. Group IV shall comprise the following species of wood:

Hard maple	Birch
Beech	Rock elm
Oak	White ash
Hackberry	

Nos. 2½ and 3 Cans, Group IV. 15. Boxes for two dozen No. $2\frac{1}{2}$, two dozen No. 3, and two dozen extra size No. 3 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{1}{2}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with three 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain. When one-piece sides are used, the third corrugated fastener may be omitted.

The sides, tops and bottoms shall be of sawed lumber

$\frac{1}{4}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be seven 4*d* standard, cement-coated box nails, not less than $1\frac{5}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{1}{2}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued, and the top and bottom nailed with not less than fourteen 4*d* standard, cement-coated box nails in each top and each bottom.

Nos. 1 and 2 Cans, Group IV.

16. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

(*a*) *Nailed Construction.*—The ends shall be $\frac{1}{2}$ in. thick and of one or two pieces. Two-piece ends shall be cleated or fastened with two 1 by $\frac{3}{8}$-in. corrugated steel fasteners, driven transversely with the grain.

The sides, tops and bottoms shall be of sawed lumber $\frac{1}{4}$ in. thick, not more than two pieces to each side or three pieces to each top or bottom. No piece shall be less than 2 in. in width.

There shall be six 4*d* standard, cement-coated box nails, not less than $1\frac{5}{16}$ in. in length, to each nailing edge.

(*b*) *Lock-Corner Construction.*—The ends shall be $\frac{1}{2}$ in. thick and the sides, top and bottom $\frac{5}{16}$ in. thick. All piecing shall be tongued, grooved and glued and the top and bottom nailed with not less than twelve 4*d* standard, cement-coated box nails in each top and each bottom.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR CANNED FOODS BOXES, WIREBOUND CONSTRUCTION.[1]

Serial Designation: D 45 – 17 T.

These specifications are issued under the fixed designation D 45; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

I. MANUFACTURE.

Manufacture. 1. Boxes shall be well manufactured from sound (free from decay or dote), well-seasoned veneer and cleat lumber. Kiln drying by excessively high temperatures or low humidities or below 6 per cent moisture shall be avoided. Veneer shall be free from knot holes, loose or rotten knots greater than 1 in. in diameter. Cleats shall be free from knots and from excessive cross grain. No knots will be permitted which will interfere with proper nailing or stapling. Each side, top, and end shall be of a single piece of veneer; the bottoms shall consist of not more than two pieces, no piece less than 4 in. in width.

Nos. 2½ and 3 Cans. 2. Boxes for two dozen No. $2\frac{1}{2}$, two dozen No. 3, and two dozen extra size No. 3 cans shall be constructed as follows:

(*a*) *Cleats.*—Each end shall be cleated with four cleats not less than $\frac{15}{16}$ by $\frac{11}{16}$ in., or any other size cleats that have equally large cross-section. One end of each cleat shall be provided

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. W. S. Topping, Secretary of Committee D-10 on Shipping Containers, 30 Vesey St., New York City.

with a tenon $\frac{1}{4}$ in. thick and $\frac{15}{16}$ in. long and the other end with the corresponding mortise. Cleats may be made of any of the following species of wood:

Red gum	Oak
Black gum	Sycamore
Maple	Ash
Birch	Hickory
Beech	Hackberry
Tupelo	Yellow pine
Elm	

(*b*) The sides, top, bottom and ends shall be of $\frac{1}{8}$-in. gum[1] veneer. The box shall be bound with four equally spaced 16-gage 0.0625-in. diameter, basic annealed wires. End wires shall be attached to cleats with 16-gage by $1\frac{1}{8}$-in. bright, soft Bessemer staples driven through the veneer into the center of the width of the cleats. Six staples shall be driven into each top and bottom cleat and four into each side cleat. Interior wires shall be attached to the veneer by 18-gage, bright, soft Bessemer staples driven through and clinched; six staples connecting each wire to top and bottom and four to each side.

(*c*) The ends shall be attached to each side cleat by four 18-gage by $\frac{13}{16}$-in. staples equally spaced, driven into the center of the cleat and at an angle of 45 to 60 deg. with the grain of the end; or by four nails $\frac{7}{8}$-in. by 15-gage by $\frac{1}{4}$-in. head, driven into the center of the cleat and equally spaced.

Nos. 1 and 2 Cans.

3. Boxes for two dozen No. 1, four dozen No. 1, and two dozen No. 2 cans shall be constructed as follows:

These boxes shall be the same as those for No. 3 cans, except that wires shall be stapled to the tops and bottoms with four staples to each wire and to the sides with three staples to each wire.

[1] Specifications for boxes of other kinds of veneer and with cleats of other species than those listed have been withheld pending tests.

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AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
INSULATED WIRE AND CABLE: 30-PER-CENT HEVEA RUBBER.[1]

Serial Designation: D 27 – 16 T.

These specifications are issued under the fixed designation D 27; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916.

Material Covered. 1. These specifications cover conductors and rubber insulation only. The design and factor of safety depend upon the service conditions and shall be at the option of the purchaser.

(*A*) *Conductor.*

I. MANUFACTURE.

Material. 2. The conductor shall be made of soft annealed copper, properly tinned, and have the properties and characteristics herein required.

Strand. 3. Each individual wire of a stranded conductor shall be considered separately and shall be designated as a strand.

Shape. 4. Each solid conductor and each strand shall be round and reasonably free from imperfections.

Stranding. 5. The stranding shall be concentric, unless otherwise specified, and shall conform to Table I.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. E. A. Barrier, Chairman of Committee D-11 on Rubber Products, 31 Milk Street, Boston, Mass.

6. For the purpose of calculating weights, cross-sections, etc., in conductivity determinations, the density of the copper shall be taken as 8.89. See Appendix I. **Density.**

TABLE I.—STRANDING.
ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Sizes.	Minimum Number of Strands in Conductor.
2 000 000 to 1 600 000 C. M.	127
1 500 000 " 1 100 000 "	91
1 000 000 " 550 000 "	61
500 000 " 250 000 "	37
No. 0000 " No. 1 A. w. g. or B. & S.	19
No. 2 " No. 8 "	7
Smaller sizes	1

II. PHYSICAL PROPERTIES AND TESTS.

7. Each solid conductor or strand shall be so drawn and annealed that after tinning it shall conform to the properties given in Table II. **Tensile Properties.**

TABLE II.—TENSILE PROPERTIES.
AMERICAN SOCIETY FOR TESTING MATERIALS.

Diameter, in.	Maximum Tensile Strength, lb. per sq. in.	Minimum Elongation in 10 in., per cent.
0.460 to 0.290 Incl.	36 000	35
0.289 " 0.103. "	37 000	30
0.102 " 0.021. "	38 500	25
0.020 " 0.003. "	40 000	20

8. (*a*) *Method of Test.*—Tensile tests shall be made on fair samples and the elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks originally 10 in. apart. The specimen shall break between the bench marks and not closer than 1 in. to either mark. **Tension Tests.**

(*b*) *Number of Tests.*—Samples shall be taken in accordance with Section 16.

(*c*) *Retests and Rejections.*—If upon testing a sample from a coil, reel or spool of wire, the results are found to be above the stated value for tensile strength or below the stated value for elongation, tests upon two additional samples will be made and the average of the three tests shall determine acceptance or rejection.

Conductivity. 9. The conductivity of the copper shall be not less than 98 per cent of the annealed copper standard. See Appendix I.

Tinning Tests 10. (*a*) *Test.*—Each sample before stranding or insulating shall be given the following tests at the factory: The sample shall be thoroughly cleaned by immersing in redistilled petroleum ether, followed by immersion in 95-per-cent alcohol. The sample shall then be immersed in hydrochloric acid (sp. gr. 1.088) at a temperature of from 60 to 70° F. (15°.55–21°.10 C.) for one minute, washed in distilled water (the surplus water shaken off) and immersed in a solution of sodium sulfide for 30 seconds and again washed in water (the surplus water shaken off). The above operation shall be repeated four times for samples 0.02 in. in diameter or over, and three times for samples less than 0.02 in. in diameter. After the completion of the required number of cycles the samples shall not show any sign of blackening in the air which is perceptible to the eye.

(*b*) *Strength of Solution.*—The solution of sodium sulfide shall have sufficient strength to thoroughly blacken in 5 seconds a piece of untinned copper wire that has previously been cleaned in 95 per cent alcohol. The solution shall be prepared by thoroughly saturating (by boiling) a solution of sodium monosulfide with sulfur and shall have a specific gravity of 1.142 at 60° F. (15°.55 C.).

(*c*) *Number of Tests.*—Samples shall be taken in accordance with Section 16.

(*d*) *Retests and Rejections.*—If the specimen tested in accordance with Section 10 (*a*) shows any signs of blackening, two more specimens shall be tested. If one of these two additional specimens shows any signs of blackening, that coil or reel shall be rejected. If both specimens are free from any signs of blackening, the coil or reel shall be accepted. If more than

10 per cent of the samples in the entire order fail, all of the wire shall be rejected. If 10 per cent or less of the samples in the entire lot fail, each coil, reel or length may be tested and accepted or rejected upon the results of the individual tests.

III. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Diameter and Area.

11. (*a*) *Permissible Variation.*—When the diameter of solid conductors and strands is specified, the permissible variation from the specified value shall not exceed 1 per cent under or 2 per cent over for wire 0.02 in. in diameter and larger, and 0.1 mil under for wire less than 0.02 in. in diameter.

When the area of cross-section is specified, the permissible variation shall not exceed 2 per cent under the specified value.

(*b*) *Method of Gaging Diameter.*—When wire is submitted in coils, each coil shall be gaged in three places, one near each end and one approximately at the middle. When wire is submitted on spools or reels, approximately 12 ft. of the wire shall be reeled off and the wire then gaged in six places between the second foot and the twelfth foot from the end.

(*c*) *Calculation of Area.*—The area of cross-section of wire shall be calculated from the average of the measurements of the diameter made in accordance with Section (*b*). The area of cross-section of cable shall be considered to be the sum of the cross-sectional areas of its component wires, when laid out straight and measured perpendicular to their axes.

(*d*) *Rejection.*—A coil or reel shall be rejected if the average diameter obtained from the measurements made in accordance with paragraph (*b*), or the area as calculated in accordance with paragraph (*c*), is not within the limits specified in paragraph (*a*).

A coil or reel shall be rejected if any individual measurement of diameter or of area of cross-section is not within twice the limits specified in paragraph (*a*).

(*B*) *Insulation.*

IV. CHEMICAL PROPERTIES AND TESTS.

Composition of Compound.

12. (*a*) *Composition.*—The insulation shall contain exclusively Hevea rubber which has not been previously used, waxy hydrocarbons consisting of ceresin or refined paraffin, sufficient

sulfur to properly vulcanize, and fillers which are entirely inorganic mineral matter containing no red lead, carbon or bitumen.

(*b*) *Requirements.*—The vulcanized compound shall conform on analysis to the following requirements expressed as percentages, by weight, of the whole sample:

	MAXIMUM.	MINIMUM.
Rubber	33	30
Waxy hydrocarbons	4	..
Free sulfur	0.7	..

Results shall be taken between the limits given in proportion to the percentage by weight of the rubber found.

The limits allowed for 30-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.35	0.55
Unsaponifiable resins	0.45	....
Chloroform extract	0.90	....
Alcoholic potash extract	0.55	....
Total sulfur (see note)	2.10	....
Specific gravity	....	1.75

The limits allowed for 33-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.50	0.60
Unsaponifiable resins	0.50	....
Chloroform extract	1.00	....
Alcoholic potash extract	0.60	....
Total sulfur (see note)	2.30	....
Specific gravity	....	1.67

The acetone solution shall not fluoresce.

The acetone extract (60 cc.) shall not be darker than a light straw color.

Hydrocarbons shall be solid, waxy and not darker than a light brown.

Chloroform extract (60 cc.) shall not be darker than a straw color.

Contamination of the compound, such as by the use of

impregnated tapes, will not excuse the manufacturer from conforming to this specification.

NOTE.—The limit on total sulfur may be omitted at the option of the purchaser.

The compound shall be analyzed by the procedure recommended by the Joint Rubber Insulation Committee. See Appendix II.

(*c*) *Samples.*—Samples for chemical analysis shall be taken before the application of the braid and after the material has passed all physical and electrical tests. The purchaser may take samples in accordance with Section 16. The purchaser shall assure himself that all samples are free from contamination and change due to torch heating. Wherever practicable, samples shall be taken at a distance of at least 3 ft. from the end of the wire.

(*d*) *Retests and Rejections.*—The purchaser may make a chemical analysis on any one of the samples selected as above to determine if the compound meets the requirements of Section 12 (*b*). Failure of any one sample selected shall be sufficient cause to reject the wire which the sample represents, except in the case of failure to meet the requirements of either or both free sulfur and chloroform extract in accordance with Section 12 (*b*). In case of such failure the coil from which the sample was taken shall be rejected and two additional samples taken from the remainder of the order. The remainder of the order shall be accepted if both samples so selected shall meet the requirements for free sulfur or chloroform extract in accordance with Section 12 (*b*). The entire order shall be rejected if either sample fails to meet the requirements.

V. PHYSICAL PROPERTIES AND TESTS.

13. The test specimen shall have the following physical properties. **Physical Properties.**

Tensile strength, minimum, lb. per sq. in.	1000
Set, maximum in 2 in., in.	$\frac{3}{8}$
Elongation, minimum before rupture, in.	2 to 9

14. (*a*) *Tension Test.*—A test specimen having a length of not less than 2 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a test machine (maximum distance **Physical Tests.**

between jaws holding the test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the specimen breaks. The test specimen shall break between the bench marks and the tensile strength shall be calculated upon the area of the original sample.

(*b*) *Set Test.*—A second test specimen having a length of not less than 6 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a test machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at a rate of 20 in. per minute until the bench marks are 6 in. apart. After the termination of this stretch, the test specimen shall be released within 5 seconds and the set determined 1 minute after the beginning of release.

(*c*) *Elongation Test.*—After the determination of the set in accordance with paragraph (*b*), the *same* specimen shall be placed in the jaws of a test machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the specimen breaks. The test specimen shall break between the bench marks.

(*d*) *Accuracy of Machine.*—The test machine shall be accurate within 1 per cent of the breaking load.

(*e*) *Jaws.*—The jaws of the machine shall be of an approved type.

(*f*) *Temperature.*—All physical tests shall be made at a room temperature of from 65 to 85° F. (18°.33 to 29°.44 C.) inclusive, and the test specimen shall have been kept at the room temperature not less than 30 minutes prior to the tests.

Test Specimen. 15. (*a*) *Test Specimen.*—The test specimen may be the entire section of the insulation in the case of small wires, or in the case of a large wire, a segment of a section, cut with a sharp knife held tangentially to the conductor. The test specimen shall be as free as possible from surface incisions and imperfections.

(*b*) *Buffing.*—In event of any irregularities on the surface of the test specimen, it shall be made smooth and of uniform thickness within 5 per cent of the original thickness by buffing, except when large strands are used, in which case the rubber sample shall be buffed sufficiently to remove all corrugations.

(*c*) *Limits.*—There shall be no limit to the cross-section of the test specimen, except as restricted by the capacity of the test machine.

(*d*) *Calculation of Area.*—Calculation of the area of test specimen shall be made as follows:

(1) When the total cross-section of the insulation is used, the area shall be calculated as the area of the circle whose diameter is the minimum average outside diameter of the insulation minus the area of the conductor. The area of a stranded conductor shall be figured from its maximum diameter.

(2) When a slice cut from the wire by a knife held tangent to the wire is used, and the slice so cut has the cross-section of a segment of a circle, the area shall be calculated as that of the segment of a circle whose diameter is that of the insulation. The height of the segment is the wall of insulation on the side from which the slice is taken. (The values are most easily obtained from a table giving the areas of segments of a unit circle for the ratio of the height of the segment to the diameter of the circle.)

(3) When the cross-section of the slice is not a segment of a circle, the area shall be calculated from a direct measurement of the volume or from the specific gravity and the weight of a known length of a uniform cross-section.

(4) When a portion of a sector of a circle has to be taken (as in the case of large conductors with thin walls) the area shall be calculated as the thickness times the width. (This applies either to a straight test piece or one stamped out with a die, and assumes that corrugations have been removed by buffing.)

(5) When a portion of a sector of a circle has to be taken on large conductors with thick walls the area shall be calculated as the proportional part of the area of the total cross-section.

Number of Physical Test Specimens.

16. (*a*) *Less than 500 Feet.*—When an order calls for less than 500 ft., physical tests shall be waived.

(*b*) *Over 500 Feet.*—When an order calls for 500 ft. or more and is made into one or more coils, reels or lengths, samples shall be taken from 10 per cent of the coils, reels or lengths, but in all cases there shall be one sample taken.

Retests and Rejections, Physical Tests.

17. (*a*) *Retests.*—If a specimen fails to pass in either of the three tests prescribed in Section 14, two more specimens shall be taken from the same sample and the average of the results shall determine whether or not the sample complies with the requirements.

(*b*) *Rejections.*—When ten or more samples are selected in any inspection lot, all coils, reels or lengths shall be rejected if more than 10 per cent of the samples fail. If 10 per cent or less fail, each coil, reel or length may be tested and shall be accepted or rejected upon the result of individual test. Where

TABLE III.—VALUES OF TEST POTENTIALS, IN KILOVOLTS.

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths in.							
	2	3	4	5	6	7	8	10
18 A. w. g. or B. & S.	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
16 " "	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
14 " "	...	2.5	5.0	6.0	7.0	8.0	9.0	11.0
12 " "	...	2.5	5.0	6.0	7.5	8.5	9.5	11.5
10 " "	...	3.0	5.0	6.5	8.0	8.5	10.0	12.0
8 " "	...	3.0	5.0	7.0	8.0	9.5	11.0	13.0
6 " "	...	...	5.0	6.5	8.5	10.0	11.5	14.0
4 " "	...	...	4.5	6.5	8.5	10.0	11.5	14.5
2 " "	...	...	4.0	6.0	8.0	10.0	12.0	15.0
0 " "	...	...	...	5.5	8.0	10.0	12.0	15.5
00 " "	...	...	...	5.0	7.5	9.5	11 5	15.5
000 " "	...	...	...	5.0	7.5	9.5	11.5	15.5
0000 " "	...	...	...	4.5	7.0	9.0	11.5	15.5
250 000 C. M.	...	...	...	4.0	6.5	9.0	11.0	15.5
500 000 "	...	...	...	2.5	5.0	7.5	10.0	14.5
750 000 "	...	..	...	...	...	6.5	9.0	14.0
1 000 000 "	...	...	...	...	...	5.5	8.0	13.0
1 250 000 "	...	...	...	...	...	...	7.5	12.5
1 500 000 "	...	...	...	...	...	...	7.0	12.0
1 750 000 "	...	...	...	...	...	...	6.5	11.5
2 000 000 "	...	...	...	...	...	...	5.0	10.5

the number of samples selected in any inspection lot is less than ten, all coils, reels or lengths shall be rejected if more than 20 per cent of the samples fail. If 20 per cent or less fail, each coil, reel or length may be tested and shall be accepted or rejected upon the result of individual test.

VI. ELECTRICAL PROPERTIES AND TESTS.

Electrical Properties

18. (*a*) *Place.*—All electrical tests shall be made at the factory.

(*b*) *Requirements.*—Every coil, reel or length of wire, after vulcanization and before the application of paraffin or

TABLE IV.—INSULATION RESISTANCE, IN MEGOHM-MILES AT 60° F.[1]

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths in.																
	2	3	4	5	6	7	8	10	12	14	16	18	20	22	24	26	28
18 A. w. g. or B. & S.	1600	2050	2450	2800	3000	3200	3400	3750	4050	4300	4500	4700	4900	5000	5150	5300	5400
16 " "	1400	1800	2150	2400	2650	2850	3050	3400	3650	3950	4150	4350	4500	4650	4800	4900	5050
14 " "	....	1530	1850	2150	2350	2550	2650	3050	3350	3550	3800	3950	4100	4300	4400	4550	4650
12 " "	....	1350	1600	1850	2050	2250	2400	2750	3000	3250	3400	3600	3750	3900	4050	4150	4300
10 " "	....	1150	1350	1600	1800	2000	2150	2400	2650	2900	3100	3250	3400	3550	3700	3800	3900
8 " "	....	850	1050	1250	1450	1650	1750	2050	2200	2400	2600	2750	2900	3050	3150	3250	3350
6 " "	....	....	850	1050	1200	1350	1450	1750	1950	2100	2300	2450	2550	2700	2800	2900	3000
4 " "	....	....	750	850	1000	1150	1250	1450	1650	1850	2000	2150	2250	2400	2500	2600	2700
2 " "	....	....	650	750	850	950	1050	1250	1450	1600	1700	1850	1950	2100	2200	2300	2400
1 " "	....	....	600	650	750	850	1000	1150	1350	1450	1600	1750	1850	1950	2050	2150	2250
0 " "	....	....	....	600	700	800	950	1050	1200	1350	1500	1600	1700	1800	1900	2000	....
00 " "	....	....	....	550	650	750	850	950	1050	1250	1350	1500	1600	1700	1800	....	....
000 " "	....	....	....	500	600	650	750	850	1000	1150	1250	1350	1450	1550	....	....	....
0000 " "	....	....	....	450	550	600	650	800	950	1050	1150	1250	1350	1450	....	....	....
250 000 C. M.	....	....	....	400	475	575	625	725	875	1000	1100	1200	1275	....	....	....	....
350 000 "	....	....	....	350	425	475	525	675	775	850	950	1050	1125	....	....	....	....
500 000 "	....	....	....	300	375	400	475	575	675	750	850	900	....	....	....	....	....
750 000 "	....	....	....	....	....	325	400	475	525	625	700	775	....	....	....	....	....
1 000 000 "	....	....	....	....	....	300	325	400	475	550	625	....	....	....	....	....	....
1 250 000 "	....	....	....	....	....	....	325	375	425	500	575	....	....	....	....	....	....
1 500 000 "	....	....	....	....	....	....	300	325	400	475	....	....	....	....	....	....	....
1 750 000 "	....	....	....	....	....	....	275	300	375	450	....	....	....	....	....	....	....
2 000 000 "	....	....	....	....	....	....	200	275	325	425	....	....	....	....	....	....	....

NOTE.—For intermediate sizes, use values of next larger size.

[1] This table is based on the constant 4000 in the following formula:

$R = K \log \frac{D}{d}$, where R = resistance in megohms, K = Constant, D = diameter over insulation, d = diameter over conductor.

any covering other than tape or braid used in vulcanization, shall successfully withstand a high voltage test as specified in Table III, and shall have an insulation resistance not less than that specified in Table IV. These tests shall be made after not less than 18 hours immersion in water, and while still immersed.

High Voltage Test.

19. The test voltage shall be applied for 5 minutes. The test shall be made in accordance with the Standardization Rules of the American Institute of Electrical Engineers. See Appendix I.

TABLE V.

(TESTS SHALL BE MADE AT TEMPERATURES WITHIN THE SCOPE OF THIS TABLE.)

Temperature.		Coefficient.	Temperature.		Coefficient.
Deg. Fahr.	Deg. Cent.		Deg. Fahr.	Deg. Cent.	
46	7.8	0.694	61	16.1	1.026
47	8.3	0.709	62	16.7	1.053
48	8.9	0.729	63	17.2	1.081
49	9.4	0.746	64	17.8	1.109
50	10.0	0.769	65	18.3	1.138
51	10.6	0.787	66	18.9	1.169
52	11.1	0.806	67	19.4	1.200
53	11.7	0.833	68	20.0	1.231
54	12.2	0.854	69	20.6	1.264
55	12.8	0.877	70	21.1	1.297
56	13.3	0.900	71	21.7	1.331
57	13.9	0.917	72	22.2	1.366
58	14.4	0.943	73	22.8	1.402
59	15.0	0 970	74	23.3	1.438
60	15.6	1.000	75	23.9	1.477

Insulation Resistance.

20. (*a*) *Method.*—This test shall be made in accordance with the Standardization Rules of the American Institute of Electrical Engineers. See Appendix I.

(*b*) *Temperature Coefficient.*—The insulation resistance (megohms) shall be reduced to that at 60° F. (15°.55 C.) by multiplying by the coefficient in Table V corresponding to the temperature at which test is made.

Rejections. Electrical Test.

21. Every coil, reel or length shall be rejected if it fails to comply with the electrical requirements herein specified.

(*C*) *Inspection.*

Inspection.

22. (*a*) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the wire or cable to permit of arrangement for the inspection.

(*b*) The inspector representing the purchaser shall have free entry at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the wire ordered, except compounding room. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the wire is being furnished in accordance with these specifications. Tests and inspection shall be made prior to shipment, at the place of manufacture.

(*c*) The purchaser may make the tests to govern the acceptance or rejection of the wire in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

23. Samples of rejected material shall be preserved for two weeks from date of test report. In case of dissatisfaction with the results of test, the manufacturer may make claim for a rehearing within that time. Sealed duplicate samples may be retained by the manufacturer at his option. **Rehearing.**

APPENDIX I.

EXTRACTS FROM STANDARDIZATION RULES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

(Edition July 1, 1915.)

Conductivity of Copper.

1. The following shall be taken as normal values for standard annealed copper:

(*a*) At a temperature of 20° C. the resistance of a wire of standard annealed copper 1 m. in length and of a uniform section of 1 sq. mm. is $1/58$ ohm $=0.017241$ ohm.

(*b*) At a temperature of 20° C. the density of standard annealed copper is 8.89 g. per cubic centimeter.

(*c*) At a temperature of 20° C. the "constant mass" temperature coefficient of resistance of standard annealed copper, measured between two potential points rigidly fixed to the wire, is $0.00393=1/254.45\ldots$ per degree Centigrade.

(*d*) As a consequence, it follows from (*a*) and (*b*) that at a temperature of 20° C. the resistance of a wire of standard annealed copper of uniform section, 1 m. in length and weighing 1 g. is $(\frac{1}{58})\times 8.89=0.15328$ ohm.

High Voltage Test.

(*a*) *Frequency.*

2. The frequency of the test voltage shall not exceed 100 cycles per second, and should approximate as closely as possible to a sine wave. The source of energy should be of ample capacity.

(*b*) *Rate of Increase of Voltage.*

3. The initially-applied voltage shall not be greater than the working voltage and the rate of increase shall not be over 100 per cent in 10 seconds.

INSULATION RESISTANCE TEST.

4. The apparent insulation resistance should be measured after the dielectric-strength test, measuring the leakage current after a one-minute electrification, with a continuous e.m.f. of from 100 to 500 volts, the conductor being maintained positive to the water.

APPENDIX II.

JOINT RUBBER INSULATION COMMITTEE PROCEDURE FOR THE ANALYSIS OF RUBBER COMPOUND.

Object of the Analysis.

1. The object of this procedure of analysis is to determine whether rubber compounds comply chemically with the accompanying specification which is intended to secure compounds containing 30 per cent of the best Hevea rubber, and mineral fillers.

Outline of Procedure.

2. The general procedure is shown in Fig. 1.

General.

3. Make the analysis upon the insulation after vulcanization and, whenever possible, before the saturation of the braid. Wipe the insulation thoroughly with a damp cloth to remove any adhering material, but do not remove waxy hydrocarbons from the surface.

4. If, however, a saturated braided sample must be used, remove the braid and sandpaper the insulation to a depth of at least 0.005 in. and wipe with a damp cloth. In such cases report the condition of the sample.

5. Perform all determinations in duplicate and take the average value arbitrarily as the true value. Duplicate determinations must check within the limits specified.

6. Make blanks on all determinations and deduct the results accordingly.

Sample.

7. Remove the insulation entirely from sufficient wire to give a sample weighing about 25 g. Cut this into small strips and grind slowly in either a No. 0 Enterprise coffee mill or a

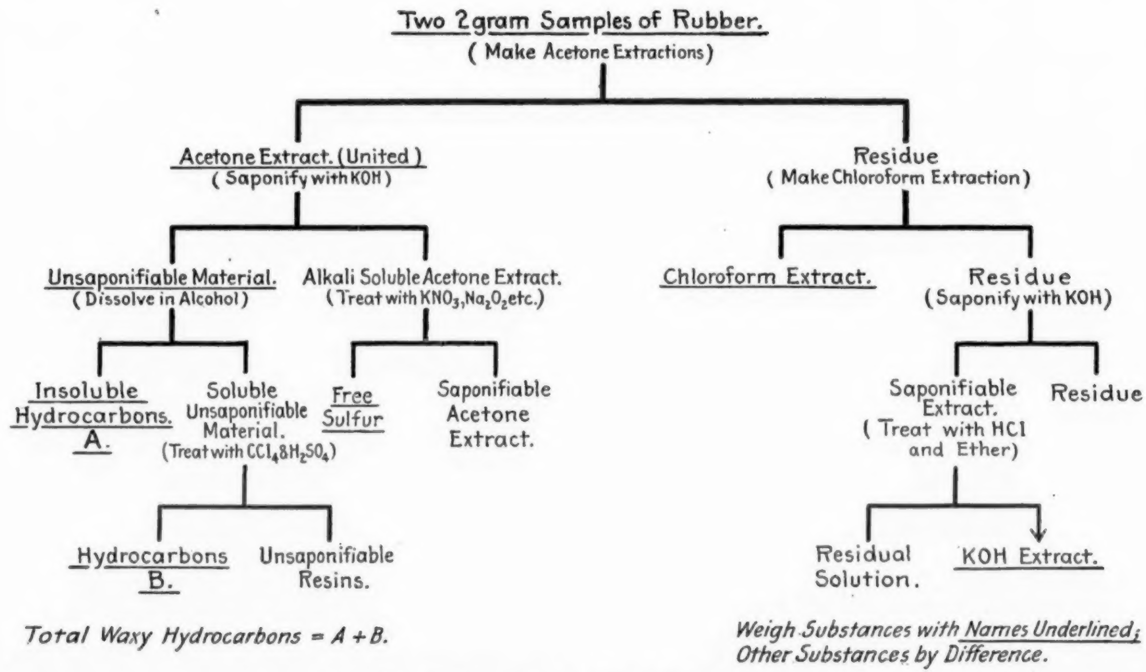


FIG. 1.—Outline of Method For Rubber Analysis.
(Exclusive of Fillers and Total Sulfur Determinations.)

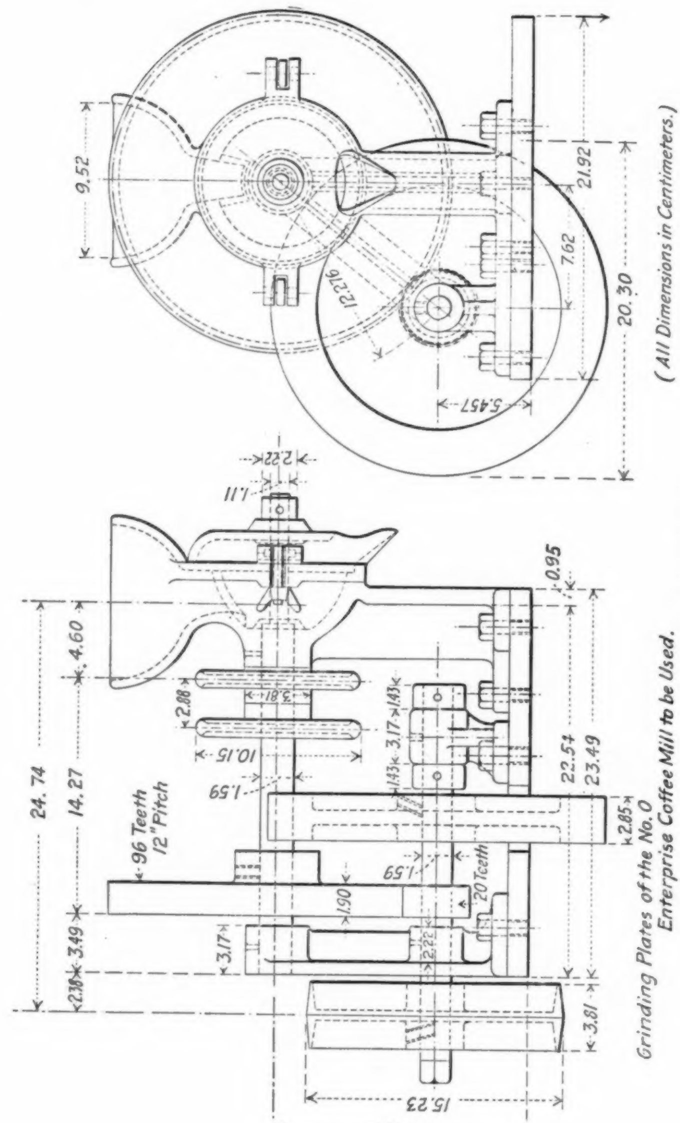
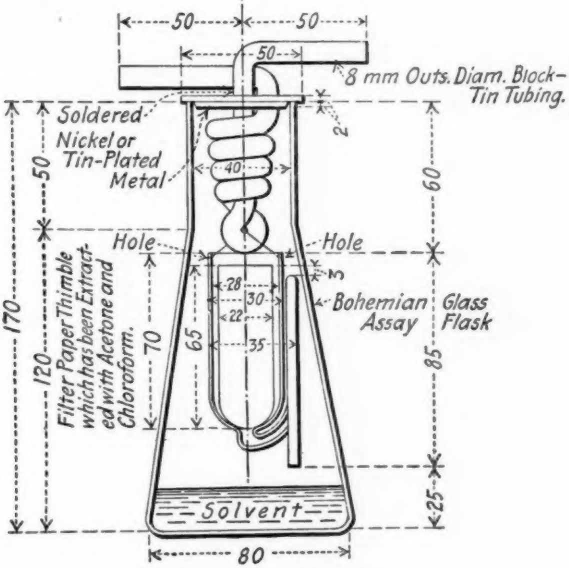


FIG. 2.—Rubber Grinder.

mill such as shown by Fig. 2. Adjust the grinder so that not more than 20 per cent will pass through a 40-mesh sieve. Sift all the material through a 20-mesh sieve, regrinding what is retained on the sieve until the entire sample has passed through. The wires of the sieves shall be evenly spaced in both directions and shall be of 0.016 and 0.010 in. diameter in the 20 and 40-mesh sieves respectively. Remove with a strong magnet any metal that may have come from the grinder and thoroughly mix the sample.



(All dimensions in millimeters.)

FIG. 3.—Extraction Apparatus.

EXTRACTION APPARATUS.

8. The extraction apparatus shall conform to Fig. 3. It shall be heated so that the period of filling an empty syphon cup with acetone and completely emptying it, will be between $2\frac{1}{2}$ and $3\frac{1}{2}$ minutes.

PREPARATION OF REAGENTS.

9. Acetone shall be freshly distilled over anhydrous K_2CO_3, using the fraction 56–57° C. **Acetone.**

KOH.

10. Alcoholic KOH solution shall be of normal strength and shall be made freshly by dissolving the proper amount of KOH (purified by alcohol) in 95 per cent alcohol which has previously been distilled over KOH. The solution shall be allowed to stand for 24 hours and only the clear liquid used.

Ether.

11. Ether shall be washed with three successive portions of distilled water and distilled, using the fraction 34–36° C.

Chloroform.

12. Chloroform shall be pure and freshly distilled.

Carbon Tetrachloride.

13. Carbon tetrachloride shall be pure and freshly distilled.

14. Reagents not otherwise specified shall be c.p. Water shall be distilled.

ACETONE EXTRACT.

Acetone Extract.

15. Extract continuously with 60 cc. of acetone for 8 hours, two 2-g. samples that have been prepared within 24 hours. Unite the extracts in a weighed flask, using hot chloroform to rinse the flasks. Distill off the reagents and dry the flask and contents for 4 hours at 95–100° C. Desiccate until cool and weigh. Continue to dry for 2-hour periods until constant weight is obtained. In drying, place the flask on its side but at a sufficient angle from the horizontal so that the extract does not appreciably run down the side of the flask.

UNSAPONIFIABLE MATERIAL.

Unsaponifiable Matter.

16. Add to the acetone extract 50 cc. of alcoholic KOH solution, boil under a reflux condenser for 2 hours, and evaporate to dryness, removing all alcohol. Add 10 cc. of water and 20 cc. of ether; heat until the wax, etc., are in solution, cool, transfer to a separatory funnel, wash out the flask with warm water and then cool, finally with two 20-cc. portions of ether. The water volume should be 100 cc. and the ether at least 40 cc. Shake vigorously for 2 minutes, and allow the solutions to separate thoroughly. Draw off the aqueous solution into a second funnel, leaving in the first funnel the ethereal solution and any flocculent material that may be present. Again rinse the flask with 20 cc. of ether and add it to the aqueous solution; shake vigorously for 2 minutes, and when separated draw off the aqueous solution and unite in the first funnel the ethereal solutions and any flocculent material. Repeat, shaking with 20-cc.

portions of ether until the extraction is complete, using at least 120 cc. of ether. Wash the flask and the funnel, from which the ethereal solution has been taken, with water, until they are free from alkali, subsequently using this wash water to wash the ethereal solution. Continue washing with water until it has been washed twice after it shows no alkaline reaction. Retain with the ethereal solution any flocculent material. Filter the ethereal solution from the flocculent material, through a small pellet of extracted cotton, into a weighed flask, washing first with ether and subsequently with hot chloroform, using this to rinse the original flask and both separatory funnels. Evaporate the solvents and dry the extract to constant weight at 95 to 100° C.; desiccate until cool and weight.

Hydrocarbons A.

Hydrocarbons A.

17. Add 50 cc. absolute alcohol to the unsaponifiable material and warm until solution is as complete as possible. Cool the solution to −4 or −5° C. and maintain at this temperature for 1 hour by packing the flask in a mixture of ice and salt. Filter out the waxy hydrocarbons, using a funnel packed with ice and salt, and apply suction if necessary. Wash the flask and filter with about 25 cc. of 95 per cent alcohol, which has been previously cooled in the same temperature. Catch the filtrate in a flask which is afterwards cooled to −4 or −5° C. to make sure that all possible waxy hydrocarbons have been removed, and refilter if necessary. Dissolve the residue on the filter paper with hot chloroform, into the original flask. Evaporate the chloroform and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

Hydrocarbons B.

Hydrocarbons B.

18. Evaporate the alcohol from the flask containing the alcoholic soluble unsaponifiable material, add 25 cc. carbon tetrachloride and transfer to a separatory funnel. Shake with concentrated H_2SO_4, drain off the discolored acid and repeat with fresh portions of acid until there is no longer any discoloration. After drawing off all the acid, wash the carbon tetrachloride solution with repeated portions of water until all traces of acid

are removed. Transfer the carbon tetrachloride solution to a weighed flask; evaporate off the solvent and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

FREE SULFUR.

Free Sulfur. 19. Add 2 g. KNO_3 to the aqueous solution and washings from the ethereal separation of the unsaponified material. Evaporate to dryness in a silver or nickel dish and heat to quiet fusion, avoiding contamination with sulfur fumes. Transfer with water to an evaporating dish, acidify with HCl, evaporate to dryness, and dehydrate silica. Add 2 cc. concentrated HCl, take up in water, filter and wash, making a volume of 200 cc. Heat to boiling and add slowly a slight excess of hot 10 per cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate the sulfur.

DEFINITION OF TERMS DESCRIBING COMPONENTS OF ACETONE EXTRACT.

Organic Extract. 20. The difference between the Acetone Extract and the Free Sulfur shall be called the Organic Extract.

Saponifiable Acetone Extract. 21. The difference between the Organic Extract and the Unsaponifiable Material shall be called the Saponifiable Acetone Extract.

Waxy Hydrocarbon. 22. The sum of the Hydrocarbons A and B shall be called the total Waxy Hydrocarbons.

Unsaponifiable Resins. 23. The difference between the Unsaponifiable Material and the Waxy Hydrocarbons shall be called Unsaponifiable Resins.

CHLOROFORM EXTRACT.

Chloroform Extract. 24. Extract continuously the residues from both of the acetone extractions (without necessarily removing the acetone that may be on them) for 4 hours with 60 cc. of chloroform, unite the extractions in a weighed flask, using hot chloroform to rinse the flasks. Distill off the solvent and dry the flask and contents for 2 hours at 95 to 100° C. Desiccate until cool and weigh. Continue to dry for 1-hour periods until constant weight is obtained. In drying, place the flask on its side but at a sufficient angle from the horizontal so that the extract does

not appreciably run down the side of the flask. (If it is needful to wait after the acetone extraction, before starting the chloroform extraction, the sample must be kept in a vacuum of at least 50 mm. of mercury.)

ALCOHOLIC-POTASH EXTRACT.

25. Dry the residue from the chloroform extraction at 50 to 60° C. until odor of chloroform can no longer be detected, unite residues from the two 2-g. samples in a 200-cc. Erlenmeyer flask. Add 100 cc. alcoholic KOH solution and boil for 4 hours under a reflux condenser. Filter the solution by decantation through an 11-cc. hardened filter paper into a beaker and wash twice, using each time 25 cc. hot absolute alcohol and then wash thoroughly with hot water. Wash any rubber on the filter paper back into the original flask and reserve this for the determination of the rubber hydrocarbons. Evaporate the solution to approximate dryness, take up in warm water and transfer to a separatory funnel. Acidify with 15 cc. of 5 normal HCl, using this to rinse the beaker. Add sufficient water to make the bulk of the solution 100 cc. When cool add 40 cc. of ether, using it to rinse the beaker in 20-cc. portions. Shake the aqueous and ethereal solutions thoroughly. After complete separation, draw off the aqueous solution and treat in another separatory funnel, with a fresh 20-cc. portion of ether. Continue to shake the aqueous solution with fresh portions of ether until a colorless portion has been obtained, then shake out twice more. Unite the ethereal solutions and wash with successive additions of water, continuing twice after the water shows no acid reaction. Filter through a plug of extracted cotton into a tared flask, wash the filter and funnel with ether, evaporate the ether without boiling and dry the residue to constant weight at 95 to 100° C. Cool in a desiccator and weigh. **Alcoholic KOH Extract.**

RUBBER HYDROCARBONS.

26. Add to the flask containing the rubber residue from the alcoholic KOH extraction, sufficient water to make the total volume of the solution 125 cc. and then add 25 cc. concentrated HCl. Heat for an hour at 97 to 100° C. Decant the supernatant liquid through a hardened filter paper on a Buch- **Rubber Hydrocarbons.**

ner funnel 7 cm. diameter, using suction; wash the residue with 25 cc. hot water and decant. (While a Buchner funnel is recommended, it is permissible to use an 11-cm. hardened filter paper with platinum cone, in a 60-deg. funnel.) Perform this entire treatment with water and HCl three times and save the first and second decantations for the "organic matter" test described in Section 33. The rubber at this stage should be white and practically free from black specks of undissolved fillers; if not, continue the acid treatment until the black specks disappear. (If carbon is present, all the particles of rubber will be grayish, bluish, or black, depending on the form and quantity of carbon used. Black specks in light particles of rubber usually indicate the presence of lead sulfide which must be removed to prevent the formation of lead sulfate on igniting the residue *C*.) Add 150 cc. of hot water to the flask and let stand on a steam bath or hot plate for half an hour and decant through the filter paper, repeating until washings are free from chlorides. (See Section 33.) Transfer all the rubber in the flask to the filter paper and dry as much as possible by suction. Wash the rubber with 50 cc. of 95-per-cent alcohol, using suction. Transfer the entire residue to a weighing bottle. Dry at 95 to 100° C. for an hour, cool in a vacuum desiccator under reduced pressure and weigh. Dry for a half hour, cool and weigh, repeating this process until either constant weight is reached or the weight starts to increase. Let this weight be represented by *C*. Determine the ash (*E*) on a portion (*D*) of this residue (*C*) and sulfur (*H*) on the remaining portion (*G*). Also determine the sulfur (*F*) on the ash (*E*). Perform the ash determination as described under ash in Rubber Residue and the sulfur determinations as described under Total Sulfur. Then,

$$\text{Rubber hydrocarbons} = 100\,\frac{C}{4}\left(1-\frac{H}{C}-\frac{E-F}{D}\right)$$

expressed as a percentage of the total sample.

ASH IN RUBBER RESIDUE.

Ash in Rubber Residue.

27. Place about 0.5 g. (*D*) of residue *C* into a weighed porcelain crucible and heat gently, gradually driving off the

volatile matter. When the crucible has ceased to smoke, raise the temperature gradually to between 450 and 500° C., until all organic matter has been burned away, which is usually indicated by the ash becoming white. (an electric muffle furnace with pyrometer is recommended for this purpose.) Cool in a desiccator and weigh, the weight of ash being represented by E in the formula for rubber hydrocarbons. Make sulfur test on ash by the method described under Total Sulfur. If, however, the ash (E) is not over 0.08 D, the determination of sulfur in the ash may be omitted, and F assumed to be zero.

TOTAL SULFUR.

28. Mix a 0.5-g. sample with 4 g. of Na_2O_2 and 6 g. of K_2CO_3 in a dry 15-cc. iron crucible. Cover and heat gradually until the mixture fuses, proceeding cautiously, as rapid heating will cause an explosion, and then bring to quiet fusion for 15 to 20 minutes. Apply the heat so as to avoid contamination with sulfur fumes. Rotate the crucible while the melt solidifies. When cool, put crucible and cover into a casserole containing 200 cc. of water; add 5 to 10 cc. of bromine water and boil until the melt is dissolved. Allow the precipitate to settle, decant the liquid through a thick filter and wash the residue with hot water. Acidify the filtrate with HCl, evaporate to dryness and dehydrate silica; add 2 cc. of concentrated HCl, take up in water, filter and wash, making the total volume about 100 cc. Heat to boiling and add slowly a slight excess of hot 10-per-cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate to sulfur. **Total Sulfur.**

SPECIFIC GRAVITY.

29. The specific gravity shall be the ratio of the weight of a given volume of the rubber to the weight of an equal volume of water, both at 20° C. Cut strips of the largest applicable size from the conductor and use about 5 g. for the sample. Determine the specific gravity in the usual manner by means of a specific gravity bottle. Care must be taken that no air bubbles adhere to the sample. **Specific Gravity.**

CHECKS.

Checks.

30. Specific gravity determinations shall check within 0.01. The other duplicate determinations shall check within the following limits expressed as percentages of the original sample.

DETERMINATION.	CHECK.
Acetone extract	0.10
Saponifiable acetone extract	0.10
Unsaponifiable resins	0.10
Waxy hydrocarbons	0.10
Free sulfur	0.05
Chloroform extract	0.10
Alcoholic potash extract	0.10
Rubber hydrocarbons	0.20
Total sulfur	0.10

INTERPRETATION.

Interpretation.

31. The rubber shall be considered to be the sum of the rubber hydrocarbons, saponifiable acetone extract, unsaponifiable resins and chloroform and alcoholic potash extracts, expressed as percentages. If the chloroform extract is over 3.0 per cent of the rubber so calculated, subtract the excess from the rubber. If the KOH extract is over 1.8 per cent of the rubber as first calculated, subtract this excess also from the rubber.

RED LEAD.

Red Lead.

32. Dissolve 1 g. of the sample in 75 cc. of xylol at a temperature of about 100° C. When the rubber is dissolved, the absence of any red particles indicates the absence of red lead. If red particles are present, filter the solution into a Gooch crucible and wash thoroughly with benzol, acetone and alcohol successively. Remove the felt and residue to a distilling flask, add HCl, and distill over the chlorine liberated by the lead peroxide, absorbing the gas in a solution of KI and starch. Not more than 0.1 cc. of N/10 thiosulfate shall be required to titrate the iodine liberated.

ORGANIC FILLERS.

Organic Filler.

33. Transfer the first and second decantations of the HCl solutions to a carefully cleaned porcelain dish and add 20 cc.

concentrated H_2SO_4. Place dish on steam bath or hot plate to drive off water and HCl. A pronounced charring of the residue indicates the presence of organic matter soluble in water or hydrolyzed by HCl. Examine filter paper and rubber while decanting acid solution and washing free of chlorides. Some types of organic fillers not removed by water and HCl, would be plainly visible at this point. Place a small portion of residue *C* under a microscope and examine for fibrous and other characteristic organic material. If organic fillers are indicated and not clearly proven by this test, place 1 g. of the original sample in a beaker, add 50 cc. of xylol and heat on hot plate until the rubber is dissolved. Decant xylol solution and wash residue with ether several times by decantation. Dry residue and examine under the microscope.

STATEMENT OF RESULTS.

Statement of Results.

34. The results of the analysis shall be stated in the following form:

	PER CENT.
Acetone extract	....
Saponifiable acetone extract	....
Unsaponifiable resins	....
Waxy hydrocarbons	....
Free sulfur	....
Chloroform extract	....
Alcoholic potash extract	....
Total sulfur	....
Rubber	....
Color of acetone extract (60 cc. vol.)	....
Fluorescence in acetone extract solution (present or absent)	....
Hydrocarbons A (consistency and color)	....
Hydrocarbons B (solid or liquid)	....
Color of chloroform extract (60 cc. vol.)	....
Carbon (present or absent)	....
Red lead (present or absent)	....
Specific gravity	....

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
RUBBER BELTING FOR POWER TRANSMISSION.[1]

Serial Designation: D 53 - 18 T.

These specifications are issued under the fixed designation D 53; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered.

1. These specifications cover two classes of rubber belting for power transmission:

(*a*) *Rubber-Covered.*—Possessing a distinct rubber cover over the outside plies of rubber-frictioned canvas and extending around the edges.

(*b*) *Friction-Covered.*—Possessing no distinct rubber cover other than that imparted to the canvas by the regular rubber frictioning process.

I. MANUFACTURE.

Construction.

2. The belting shall consist of:

(*a*) Cotton reinforcement;

(*b*) Rubber friction compound;

(*c*) An outside rubber cover, when specified.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. E. A. Barrier, Chairman of Committee D-11 on Rubber Products, 31 Milk Street, Boston, Mass.

3. The reinforcement shall consist of canvas plies made from cotton duck evenly and firmly woven, as free from such defects as knots, lumps, and irregularities of twist as is consistent with the best manufacturing practice. It shall be well frictioned on both sides with a rubber compound. **Reinforcement.**

4. The seam in the outside ply of frictioned canvas shall be completely filled with a rubber cord, or "beading," well fastened down with a rubber cover-strip. **Rubber Beading.**

5. When rubber-covered belting is specified, the rubber cover shall be uniform in thickness, and free from cracks, blisters or other defects which would impair its moisture-resisting qualities. **Rubber Cover.**

II. PHYSICAL PROPERTIES AND TESTS.

6. Where applicable, references are made below to the Standard Methods for Testing Cotton Rubber-Lined Hose (Serial Designation: D 15) of the American Society for Testing Materials.[1] **Standard Methods of Testing.**

7. The temperature of the testing room and samples shall be as defined in Section 19 of Standard Methods D 15. **Temperature of Testing Room and Samples.**

8. From each lot of belting submitted for inspection a section 36 in. in length shall be cut and bench marks placed upon it 18 in. apart; it shall then be tested in a suitable tension testing machine and, under a load of 100 lb. per inch per ply, shall not stretch more than 5 per cent. **Stretch Test of Belting.**

9. The stretch test described in Section 8 shall be continued without interruption to the breaking point, which shall occur at not less than 285 lb. per inch per ply. The rate of separation of the jaws shall be approximately $\frac{1}{2}$ in. per minute. **Tensile Strength Test of Belting.**

10. For belting of greater width than 12 in. the manufacturer shall supply for stretch and tension tests a 36-in. section of belting not more than 12 nor less than 6 in. in width, guaranteed to truly represent the composition of and the treatment given the belting supplied. **Strength and Tensile Tests of Belts Wider than 12 in.**

11. (*a*) The adhesion, or friction, test between the plies shall be conducted in the following manner: For belting 4 in. and over in width transverse test specimens 1 in. in width, and for belting under 4 in. in width longitudinal test specimens **Friction Test.**

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[1] 1918 Book of A.S.T.M. Standards.

1 in. in width, shall be prepared. The test specimen shall then be mounted in a vertical position against a vertical test board by means of an eccentric clamp at the upper end, as illustrated in Fig. 1. Each ply shall be tested in turn by cutting away below the eccentric clamp and fastening the separated end in a movable clamp to which is suspended a weight which together with the clamp makes a total weight of 20 lb. The rate of separation of the plies shall not exceed 1 in. per minute.

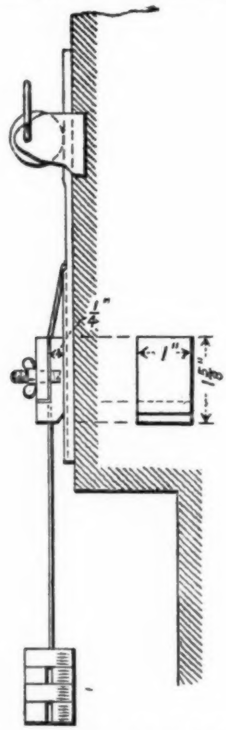

FIG. 1.—Apparatus for Friction Test.

(*b*) No test shall be made on the last three plies; but the friction between these shall be determined by using the reverse side of a fresh test specimen.

(*c*) The thickness, width and length of the inner jaw of the movable clamp shall be as shown in Fig 1.

Tests on Cover and Beading. 12. (*a*) With each lot of belting the manufacturer shall be required to furnish for test, sample pieces 8 in. in length,

at least 4 in. in width and $\frac{1}{16}$ in. in thickness, one piece consisting of cover compound (when rubber-covered belting has been specified) and the other consisting of beading compound. These sample pieces shall be guaranteed to truly represent, in each case, the composition and degree of vulcanization of the article delivered.

(*b*) The tests shall be conducted in accordance with Sections 18, 20(*a*), 22, 23, 24 and 25 of Standard Methods D 15.

(*c*) When stretched from 2 in. (the original gage length) to 7 in. for the cover, and from 2 in. to 8 in. for the beading, the set or permanent elongation shall not exceed 25 per cent.

(*d*) The tensile strength shall be not less than 800 lb. per sq. in. for the cover and 1100 lb. per sq. in. for the beading.

(*e*) The elongation at the breaking load shall be such that the original 2-in. gage length of the test specimen shall have been stretched to not less than 9 in. for the cover and to not less than 10 in. for the beading.

(*f*) The beading shall also be tested as follows: A 4-in. transverse section of belting shall be taken and beginning on the pulley or seamless side the plies shall be removed until only three remain intact. A line shall be drawn down the middle of the beading and then on each side of this line, and $\frac{5}{8}$ in. distant from it, two parallel lines shall be scribed. The section shall be inserted in a vise so that the jaws grip the sample coincident with the two outer lines. The vise shall be tightened until the inner surfaces of the doubled sample just touch at the top of the vise, and the sample shall be so held for 10 minutes. Under this test the beading shall not crack or loosen in the seam.

III. PERMISSIBLE VARIATIONS IN SIZES.

13. The width of the belting shall be not less than that specified by the purchaser, and shall not exceed that specified by more than the following limits: **Width of Belting.**

Width.	Permissible Plus Variations, in.
Up to 12 in., incl.	$\frac{1}{8}$
Over 12 to 24 in., incl.	$\frac{3}{16}$
Over 24 in., incl.	$\frac{1}{4}$

Thickness of Belting. 14. The thickness of the belting in inches shall be not less than 0.050 multiplied by the number of plies, plus the thickness of the rubber covers, if any.

Thickness of Cover. 15. The cover shall be not less than $\frac{3}{128}$ (=0.023) in. in thickness. This shall also apply to the edges.

IV. MARKING.

Marking. 16. Each roll of belting shall have the name of the manufacturer, the month and year of manufacture, the trade name of the belt, and the legend "Power A.S.T.M. Specifications" impressed in the strip side at points not more than 15 ft. apart.

Precaution. 17. Each roll of belting shall have the following words stencilled on the strip side, on the outside ply of the roll: "Run other side to pulley."

Endless Belts. 18. Endless belts shall have additional marks showing in which direction the belt shall be run with regard to the splices.

V. INSPECTION AND REJECTION.

Inspection. 19. (*a*) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the belting to permit of arrangement for inspection.

(*b*) The manufacturer shall afford the inspector representing the purchaser, without charge, all reasonable facilities to satisfy him that the belting is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*c*) The purchaser may make the tests to govern the acceptance or rejection of the belting in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rehearing. 20. Samples of rejected belting shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE SPECIFICATIONS
FOR
STEAM HOSE.[1]

Serial Designation: D 54 – 18 T.

These specifications are issued under the fixed designation D 54; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Material Covered. 1. These specifications cover wrapped steam hose, suitable for steam heat connections when the steam pressure does not exceed 125 lb. per sq. in.

I. MANUFACTURE.

Construction. 2. The hose shall consist of:

(*a*) An inner rubber tube;
(*b*) Cotton reinforcement;
(*c*) An outer rubber cover.

Rubber Tube. 3. The rubber tube shall be smooth, uniform in quality and thickness, and free from injurious defects.

Cotton Reinforcement. 4. The reinforcement shall consist of long fiber cotton having 5 threads per strand, and not less than 16 nor more than 22 strands per inch of width, for both warp and filler.

[1] Criticisms of these Tentative Specifications are solicited and should be directed, preferably before January 1, 1919, to Mr. E. A. Barrier, Chairman of Committee D-11 on Rubber Products, 31 Milk Street, Boston, Mass.

The duck shall be cut and applied on a bias, of from 42 to 46 deg., with edges lapped at least 0.5 in. and with both sides well frictioned.

Rubber Cover. 5. The rubber cover shall be uniform in quality and thickness, and free from injurious defects.

II. PHYSICAL PROPERTIES AND TESTS.

Standard Methods of Testing. 6. Where applicable, references are made below to the Standard Methods for Testing of Cotton Rubber-Lined Hose (Serial Designation: D 15) of the American Society for Testing Materials.[1]

Temperature of Testing Room and Samples. 7. The temperature of the testing room and samples shall be as defined in Section 19 of Standard Methods D 15.

Samples for Tests. 8. A portion 18 in. long shall be cut from each length of hose, except in the case of 22, 24 or 30-in. lengths, when one length from each 200 ft. or less shall be taken for test. A portion $2\frac{1}{2}$ in. long shall be cut from the test specimen and subjected to the tests specified in Section 9. The remaining portion of the test specimen shall then have the exposed ends coated with a covering of rubber cement and be subjected to the digester test as specified in Section 12, after which another $2\frac{1}{2}$-in. portion shall be cut from the test specimen and subjected to the tests specified in Section 10.

Friction Test before Steaming. 9. The quality of the rubber friction binding the plies together shall be determined by suspending a 20-lb. weight from the separated end of the duck of a 1-in. test ring cut from the $2\frac{1}{2}$-in. sample described in Section 8, the force being applied radially. The rate of separation of the plies shall not be greater than 1 in. per minute. The test shall extend for 10 minutes when the size of hose permits.

Friction Test after Steaming. 10. The quality of the rubber friction after steaming shall be determined, as described in Section 9, on a 1-in. test ring cut from the sample after it has been subjected to the digester test, except that a 15-lb. weight shall be used in place of the 20-lb. weight described in Section 9.

Tests of Tube and Cover. 11. (*a*) The tests of tube and cover shall be conducted in accordance with Sections 18, 20 (*a*), (*b*), and (*c*), 21, 22, 23, 24, and 25 of Standard Methods D 15.

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[1] 1918 Book of A.S.T.M. Standards.

(*b*) The friction between the inner tube and cotton duck shall be the same as that between the plies.

(*c*) The tensile strength before steaming shall be not less than 600 lb. per sq. in.

(*d*) The tensile strength after steaming shall be not less than 450 lb. per sq. in.

(*e*) For both the tube and cover, the elongation at the breaking load shall be such that the original 2-in. gage length shall have been stretched to not less than 6 nor more than 10 in. before steaming, and to not less than 4 nor more than 8 in. after steaming.

Digester Test.

12. The digester shall consist of a closed cylinder containing dry saturated steam at a pressure of 45 lb. per sq. in. The test specimen specified in Section 8 shall be placed in the digester and shall remain there for 48 hours continuously. An examination of the section after being subjected to the heat of the steam should be made immediately after removal from the digester, and should disclose no blistering of the inner tube or loosening of the tube from the fabric. Tests after steaming prescribed in the specifications shall be made as soon as possible after the specimen has cooled for 24 hours.

III. SIZES AND DIMENSIONS.

Sizes and Dimensions.

13. (*a*) Steam hose shall be in accordance with the sizes and dimensions specified by the purchaser.

(*b*) The thickness of cover shall be not less than $\frac{1}{16}$ in. The thickness of tube shall be not less than $\frac{1}{8}$ in

IV. WORKMANSHIP.

Workmanship.

14. The hose shall conform to the dimensions specified and shall be finished in a workmanlike manner. The tube and cover shall be free from injurious defects.

V. MARKING.

Marking.

15. (*a*) Each 50-ft. length of hose shall have inlaid in rubber in three places, namely, midway between the ends and within

10 ft. of each end, a brand showing the name of the manufacturer, the month and year of manufacture, the trade name of the hose, and the legend "A.S.T.M. Specifications." Shorter lengths than 50 ft. shall have one brand similar to the above inlaid in rubber.

(*b*) Serial numbers of rejected hose shall not be applied to any other hose during the same calendar year.

VI. INSPECTION AND REJECTION.

Inspection. 16. (*a*) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the hose to permit of arrangement for inspection.

(*b*) The manufacturer shall afford the inspector representing the purchaser, without charge, all reasonable facilities to satisfy him that the hose is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*c*) The purchaser may make the tests to govern the acceptance or rejection of the hose in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection. 17. Samples of rejected hose shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE TEST
FOR
FLASH POINT OF PAINT THINNERS OTHER THAN TURPENTINE.[1]

Serial Designation: D 28 – 18 T.

This test is issued under the fixed designation D 28; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Tester to be Used.

1. (*a*) Flash point shall be determined with the Tag Closed Tester, operated in accordance with the directions given below.

(*b*) For unofficial tests any suitable closed type of tester such as the Abel, the Abel-Pensky or the Elliott may be used.

General Directions.

2. (*a*) If gas is available, connect a $\frac{1}{8}$-in. rubber tube to the corrugated gas connection on the oil cup cover. If no gas is available, unscrew the test flame burner-tip from the oil chamber on the cover, and insert a wick of cotton cord in the burner-tip and replace it. Put a small quantity of cotton waste in the oil chamber, and insert a small quantity of signal, sperm or lard oil in the chamber, light the wick and adjust the flame, so that it is exactly the size of the small white bead mounted on the top of the tester.

[1] Criticisms of this Tentative Test are solicited and should be directed, preferably before January 1, 1919, to Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 129 York St., Brooklyn, N. Y.

This test, when adopted as standard, will be added to the Standard Tests for Paint Thinners other than Turpentine (D 28–17), 1918 Book of A.S.T.M. Standards.

(*b*) The test shall be performed in a dim light so as to see the flash plainly.

(*c*) Surround the tester on three sides with an inclosure to keep away draughts.

A shield about 18 in. square and 2 ft. high, open in front, is satisfactory, but any safe precaution against all possible room draughts is acceptable. Tests made in a laboratory hood or near ventilators will give unreliable results.

(*d*) See that the tester sets firm and level.

(*e*) For accuracy, the flash-point thermometers which are especially designed for the instrument should be used, as the position of the bulb of the thermometer in the oil cup is essential.

Water Bath. 3. Put the water-bath thermometer in place, and place a receptacle under the overflow spout to catch the overflow. Fill the water bath with water at such a temperature that, when testing is started, the temperature of the water bath will be at least 10° C. below the probable flash point of the oil to be tested.

Oil Cup. 4. Put the oil cup in place in the water bath. Measure 50 cc. of the oil to be tested in a pipette or a graduate, and place in the oil cup. The temperature of the oil shall be at least 10° C. below its probable flash point when testing is started. Destroy any bubbles on the surface of the oil. Put on the cover, with flash-point thermometer in place and gas tube attached. Light the pilot light on the cover and adjust the flame to the size of the small white bead on the cover.

Heating. 5. Light and place the heating lamp, filled with alcohol, in the base of the tester and see that it is centrally located. Adjust the flame of the alcohol lamp so that the temperature of the oil in the cup rises at the rate of about 1° C. per minute, not faster than 1°.1 nor slower than 0°.9 per minute.

Testing. 6. (*a*) Record the barometric pressure which, in the absence of a laboratory instrument, may be obtained from the nearest Weather Bureau Station.

(*b*) Record the temperature of the oil sample at start.

(*c*) When the temperature of the oil reaches about 5° C. below the probable flash point of the oil, turn the knob on the cover so as to introduce the test flame into the cup, and turn it *promptly* back again. Do not let it snap back. *The time consumed in turning the knob down and back should be about one full*

second, or the time required to pronounce distinctly the words "one-thousand-and-one."

(*d*) Record the time of making the first introduction of the test flame.

(*e*) Record the temperature of the oil sample at the time of first test.

(*f*) Repeat the application of the test flame at every 0°.5 C. rise in temperature of the oil until there is a flash of the oil within the cup.

Do not be misled by an enlargement of the test flame or halo around it when entered into the cup, or by slight flickering of the flame; the true flash consumes the gas in the top of the cup and causes a very slight explosion.

(*g*) Record the time at which the flash point is reached.

(*h*) Record the flash point.

(*i*) If the rise in temperature of the oil, from the "time of making the first introduction of the test flame" to the "time at which the flash point is reached" was faster than 1°.1 or slower than 0°.9 C. per minute, the test should be questioned, and the alcohol heating lamp adjusted so as to correct the rate of heating. It will be found that the wick of this lamp can be so accurately adjusted as to give a uniform rate of rise in temperature of 1° C. per minute and remain so.

Repeat Tests.

7. (*a*) It is not necessary to turn off the test flame with the small regulating valve on the cover; leave it adjusted to give the proper size of flame.

(*b*) Having completed the preliminary test, remove the heating lamp, lift up the oil cup cover, and wipe off the thermometer bulb. Lift out the oil cup, and empty and carefully wipe it. Throw away all oil samples after once used in making a test.

(*c*) Pour cold water into the water bath, allowing it to overflow into a receptacle, until the temperature of the water in the bath is lowered to 8° C. below the flash point of the oil, as shown by the previous test.

With cold water of nearly constant temperature, it will be found that a uniform amount will be required to reduce the temperature of the water bath to the required point.

(*d*) Place the oil cup back in the bath and measure into it a 50-cc. charge of fresh oil. Destroy any bubbles on the surface

of the oil, put on the cover with its thermometer, put in the heating lamp, record the temperature of the oil, and proceed to repeat the test as described above in Sections 4 to 6, inclusive. Introduce the test flame for first time at a temperature of 5° C. below the flash point obtained on the previous test.

Average Value of Flash Point.

8. If two or more determinations agree within 0°.5 C., the average of these results, corrected for barometric pressure, shall be considered the flash point. If two determinations do not check within 0°.5 C., a third determination shall be made and, if the maximum variation of the three tests is not greater than 1° C., their average, after correcting for barometric pressure, shall be considered the flash point.

Correction for Barometric Pressure.

9. A correction table is furnished with each instrument, for converting the results of tests made at varying barometric pressures to equivalent temperatures at the standard barometric pressure of 760 mm.

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TENTATIVE TESTS

FOR

DETERMINATION OF APPARENT SPECIFIC GRAVITY OF SAND, STONE AND SLAG SCREENINGS, AND OTHER FINE NON-BITUMINOUS HIGHWAY MATERIALS.[1]

Serial Designation: D 55 – 18 T.

These tests are issued under the fixed designation D 55; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1918.

Alternate Methods. 1. The following tests, "Le Chatelier" and "Jackson," are equally suited for use in determining the apparent specific gravity of sand, stone and slag screenings and other fine non-bituminous highway materials, and may be considered as alternates:

I. LE CHATELIER TEST.

Apparatus. 2. The determination of specific gravity shall be made with a standardized Le Chatelier apparatus which conforms to the requirements illustrated in Fig. 1. This apparatus is standardized by the United States Bureau of Standards. Kerosene free from water, or benzine not lighter than 62° Baume, shall be used in making this determination.

[1] Criticisms of these Tentative Tests are solicited and should be directed, preferably before January 1, 1919, to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, Office of Public Roads and Rural Engineering, Washington, D. C.

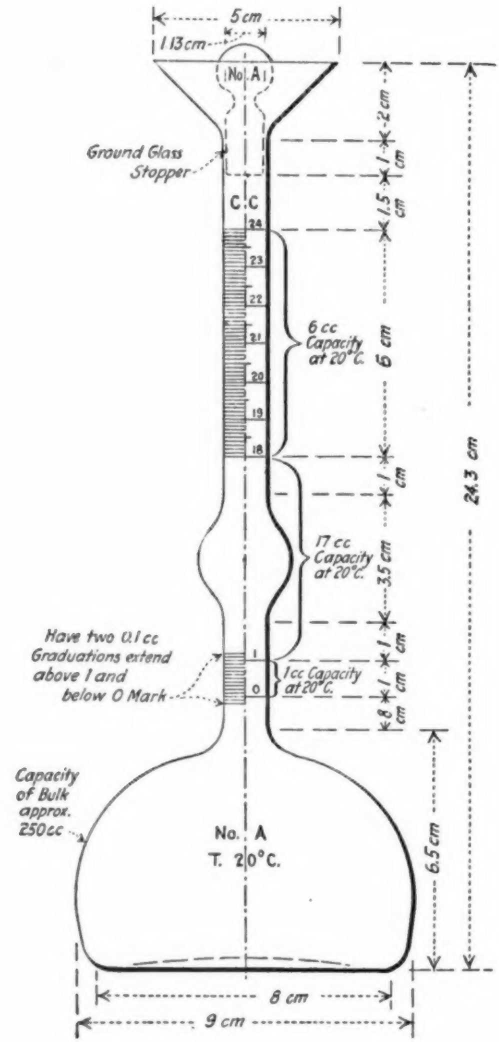


FIG. 1.—Le Chatelier Apparatus.

3. (*a*) The flask shall be filled with either of these liquids to a point on the stem between zero and one cubic centimeter and 64 g. of sand or other fine non-bituminous highway material of the same temperature as the liquid, shall be slowly introduced, taking care that the material does not adhere to the inside of the flask above the liquid and to free the material from air by rolling the flask in an inclined position. After all material is introduced, the level of the liquid will rise to some division of the graduated neck; the difference between readings is the volume displaced by 64 g. of the material. **Method.**

The specific gravity shall then be obtained from the formula

$$\text{Specific gravity} = \frac{\text{Weight of material (g.)}}{\text{Displaced volume (cc.)}}$$

(*b*) The flask, during the operation, shall be kept immersed in water, in order to avoid variations in the temperature of the liquid in the flask, which shall not exceed 0°.5 C. The results of repeated tests should agree within 0.01.

II. JACKSON TEST.

4. The determination shall be made with a Jackson specific-gravity apparatus (illustrated in Fig. 2) which shall consist of a burette, with graduations reading to 0.01 in specific gravity, about 23 cm. (9 in.) long and with an inside diameter of about 0.6 cm. (0.25 in.), which shall be connected with a glass bulb approximately 13 cm. (5.5 in.) long and 4.5 cm. (1.75 in.) in diameter, the glass bulb being of such size that from a mark on the neck at the top to a mark on the burette just below the bulb, the capacity is exactly 180 cc. (6.09 liquid oz.); and an Erlenmeyer flask, which shall contain a hollow ground-glass stopper having the neck of the same bore as the burette, and shall have a capacity of exactly 200 cc. (6.76 oz.) up to the graduation on the neck of the stopper. **Apparatus.**

5. The method is as follows: **Method.**

(1) Dry at not more than 110° C. (230° F.) to a constant weight a sample weighing about 55 g.; (2) weigh 50 g. of the dry sample to 0.1 g. and pour it into the unstoppered Erlenmeyer flask, which shall be cleaned and dried before each determination; (3) fill the bulb and burette with kerosene, leaving just space

enough to take the temperature by introducing a thermometer through the neck; (4) remove the thermometer and add sufficient kerosene to fill exactly to the mark on the neck, drawing

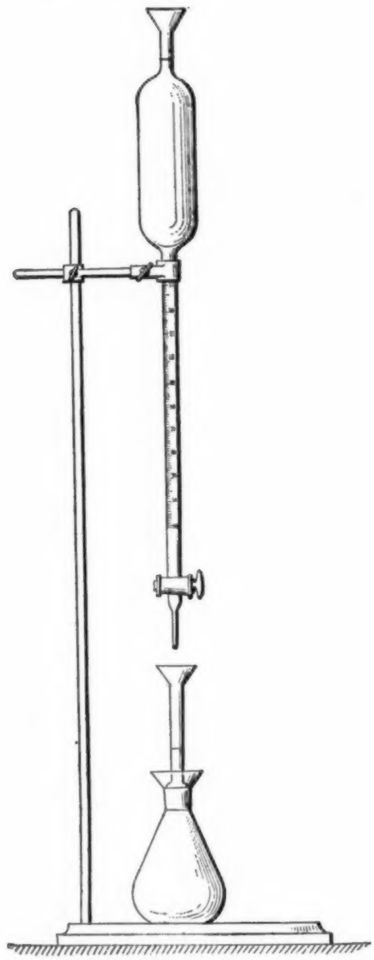


FIG. 2.—Jackson Apparatus.

off any excess with the burette; (5) run into the flask about one-half of the kerosene in the bulb to remove air bubbles and then run in more kerosene, removing any material adhering to

the neck of the flask, until the kerosene is just below the ground glass; (6) place the hollow ground-glass stopper in position and turn it to fit tightly, and then run in kerosene exactly to the 200-cc. (6.76-oz.) graduation on the neck, care being taken to remove all air bubbles in the flask; (7) read the specific gravity from the graduation on the burette, and the temperature of the oil in the flask, noting the difference between the temperature of the oil in the bulb before the determination and that of the oil in the flask after the determination; (8) make a temperature correction to the reading of the specific gravity in accordance with the table furnished by the manufacturer of the apparatus, adding the correction if the temperature of the kerosene has increased and subtracting it if the temperature of the kerosene has decreased.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE TESTS FOR MOLDED INSULATING MATERIALS.[1]

Serial Designation: D 48 – 17 T.

These tests are issued under the fixed designation D 48; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917.

Material Covered. 1. These tests are intended to apply to all solid insulating materials that are formed in molds or between platens by the application of pressure, either with or without heat.

I. PHYSICAL PROPERTIES AND TESTS.

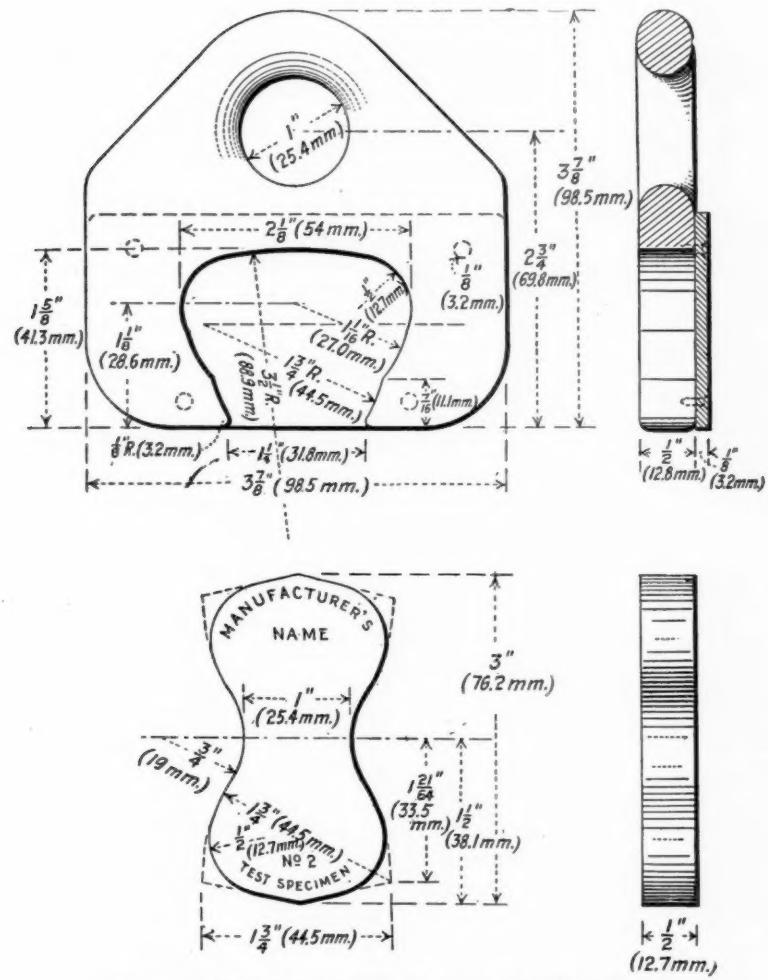
(*A*) *Mechanical.*

TENSILE STRENGTH.

Specimen. 2. The standard test specimen shown in Fig. 1 shall be used for the tension test. It shall be molded in a hardened and ground steel mold to the dimensions given in Fig. 1.

Apparatus. 3. Any standard testing machine may be used. Special clips (see Fig. 1) of hardened steel shall be used, hung from links held in the jaws of the machine, so that the pull is central at all times, to avoid any transverse strain.

[1] Criticisms of these Tentative Tests are solicited and should be directed, preferably before January 1, 1919, to Mr. C. E. Skinner, Chairman of Committee D-9 on Electrical Insulating Materials, W. E. & M. Co., East Pittsburgh, Pa.



Make Steel Mold to these Dimensions. Limits ± 0."002 (0.05mm.)

FIG. 1.—Tension Test Specimen (Specimen No. 2.)

Method. 4. (*a*) Six specimens shall be tested in the condition in which they are received.

Three specimens shall be tested after heating in an oven for one hour at a temperature which is 10° C. (18° F.) below the distortion point of the material, as determined under Part (*C*), Sections 18 to 21. The test shall be made while the specimens are hot, with a permissible variation of ±5 per cent from the temperature taken.

Three specimens shall be tested after they have been entirely immersed in distilled water for 48 hours at normal room temperature. The specimens shall be pulled apart at normal room temperature of about 21° C. (70° F.) after the surface water has been removed by wiping with a dry cloth.

(*b*) The test specimen shall be pulled apart at such a speed that the beam can be kept well balanced. Make all tests at normal room temperature of about 21° C. (70° F.). Measurements may be taken at intervals during the test to show the elongation of the specimen when required for elastic materials.

Report. 5. The results of the test shall be reported in the following order:

(*a*) The breaking load of each specimen in kilograms or pounds;

(*b*) The thickness in centimeters or inches as measured by micrometer at the point of fracture;

(*c*) The average ultimate tensile strength in kilograms per square centimeter or in pounds per square inch, as calculated from the actual area of the specimen measured at the point of fracture;

(*d*) State the character of the material tested and describe how it acts under strain;

(*e*) The speed in centimeters or inches per minute at which the jaws traveled during the test.

COMPRESSIVE STRENGTH.

Specimen. 6. The test specimen shall be molded in the form of a cube from a hardened steel mold, ground to the dimensions shown in Fig. 2.

Apparatus. 7. Any standard testing machine may be used. The pressure head used for standard compressive strength test on

cement blocks is satisfactory for this purpose. Place a sheet of lead $\frac{1}{16}$ in. thick both above and below the specimen to adjust irregularities.

8. (*a*) Six specimens shall be crushed in the condition in which they are received. **Method.**

Three specimens shall be crushed after heating for one hour at a temperature which is 10° C. below the distortion point of the material, as determined under Part (*C*), Sections 18 to 21. The test shall be made while the specimens are hot, with a permissible variation of ±5 per cent from the temperature taken.

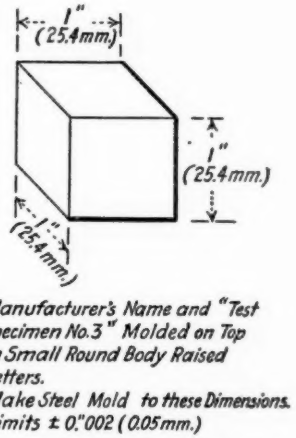


FIG. 2.—Compression Test Specimen (Specimen No. 3).

Three specimens shall be crushed after immersion in distilled water at normal room temperature for 48 hours, with all surface water wiped off with a dry cloth.

(*b*) The load shall be applied at such a rate of speed that will permit the beam to be kept well balanced, from zero load until the specimen is crushed. For best results use the slowest possible speed.

9. The results of the test shall be reported in the following order: **Report.**

(*a*) The dimensions of each specimen in millimeters or in inches;

(*b*) The breaking load in kilograms or in pounds, on each specimen at the first sign of failure.

(*c*) The average ultimate compressive strength in kilograms per square centimeter or in pounds per square inch, of each set of specimens, calculated from the measured area of each specimen before the load is applied.

(*d*) State the general character of the material tested and describe how it acts under the applied load;

(*e*) The speed in centimeters or inches per minute at which the jaws traveled during the test.

TRANSVERSE STRENGTH.

Specimen. 10. The test specimen shall be molded from a hardened steel mold, ground to the dimensions shown in Fig. 3.

Apparatus. 11. Any standard testing machine may be used. The speci-

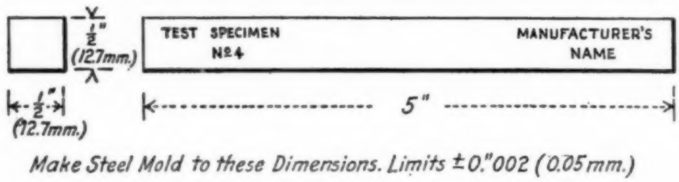


FIG. 3.—Transverse Test Specimen (Specimen No. 4).

men shall be supported on two steel blocks, with corners rounded to $1\frac{1}{2}$-mm. ($\frac{1}{16}$-in.) radius. These supports shall be 100 mm. (3.94 in.) apart. The load shall be applied on top of this specimen by means of a wedge-shaped pressure piece, the edge of which is rounded to a 3-mm. ($\frac{1}{8}$-in.) radius, extending across the specimen with the edge parallel to the edges of the two supports. The angle of the wedge shall be approximately 45 deg., and the load shall be applied at right angles to the specimen midway between the supports. The specimen shall be laid flat upon the supports at equal distances from the edges at each end.

Method. 12. (*a*) Six specimens shall be tested in the condition in which they are received.

Three specimens shall be tested after immersion in distilled water at normal room temperature for 48 hours, with all surface water wiped off with a dry cloth.

(*b*) The load shall be applied at as slow a speed as possible, so that the beam may be kept well balanced from zero load until the first sign of failure. All tests shall be made at room temperature of about 21° C. (70° F.). Measurements of the deflection may be taken for very elastic materials.

13. The results of the test shall be reported in the following order: **Report.**

(*a*) The thickness of each specimen as measured by micrometer in millimeters or in inches;

(*b*) The actual breaking load of each specimen in kilograms or in pounds at the first sign of failure.

(*c*) The maximum fiber stress in kilograms per square centimeter or in pounds per square inch calculated by the formula,

$$S=\frac{3\,PL}{2\,BD^2},$$

in which S = maximum fiber stress, P = load applied, L = distance between the supports, B = width of specimen, and D = depth of specimen;

(*d*) The rate at which the load was applied;

(*e*) The amount of deflection in millimeters or inches.

(*B*) *Electrical.*

DIELECTRIC STRENGTH.

14. The test specimen shall be molded to the dimensions shown in Fig. 4. The mold shall be hardened and ground to these dimensions. If the material cannot be molded to the full height shown, the height can be reduced to $1\frac{1}{4}$ in., other dimensions remaining the same. **Specimen.**

15. (*a*) Any well-designed high tension testing transformer, connected to an alternating current supply having as nearly a true sine wave as possible, may be used. The transformer and the source of supply of energy shall not be less than 5 KVA. The frequency shall not exceed 100 cycles per second. **Apparatus.**

(*b*) Regulation shall be so controlled that the high tension testing voltage taken from the secondary of the testing transformer can be raised gradually from any point. The control may be made by generator field regulation, by the potentiometer

method, with an induction regulator, or with a variable ratio auto transformer. Any method of regulating the voltage is satisfactory which does not distort the wave more than ten per cent from a sinusoidal shape.

(*c*) The voltage may be measured by any approved method, preferably by connecting a voltmeter to an auxiliary ratio transformer coil, reading square root of mean square volts in the primary of the testing transformer. A voltmeter on the low tension side of the transformer is satisfactory, if the ratio of transformation does not change under any test condition. An electrostatic voltmeter properly calibrated in the high tension circuit is also satisfactory. A spark gap may be used to check the readings at very high potentials.

Some protection is desirable in the high tension circuit of testing transformers where the voltage is from 25,000 to 100,000 volts, to prevent dangerous surges and limit the current when the test specimen is punctured. It is, however, desirable to have as much energy available as possible when puncture occurs. If impedance in the form of choke coils be used in series with the high tension terminals, it should not be greater than that which will limit the high tension current to double the normal rated current of the testing transformer.

When a spark gap is used a non-inductive resistance of about 1 ohm per volt may be inserted in series with one terminal of the spark gap, to damp high frequency oscillations at the time of breakdown and limit the current flow. This resistance shall be as near the gap as possible and in series with the test specimen. If the test is made with one side grounded this resistance shall be on the ungrounded side of the circuit, and if neither side is grounded the resistance shall be inserted one-half on each side of the spark gap. Water tube resisters are preferable to carbon for this purpose, as carbon resistance may become very low at high voltage.

(*d*) The apparatus used shall meet the requirements of the Standardization Rules of the American Institute of Electrical Engineers.

Method. 16. (*a*) Voltage shall be applied to the test specimen by placing a wet clay pat about $\frac{1}{4}$ in. thick inside the specimen and extending all around to the wall and another wet clay pat

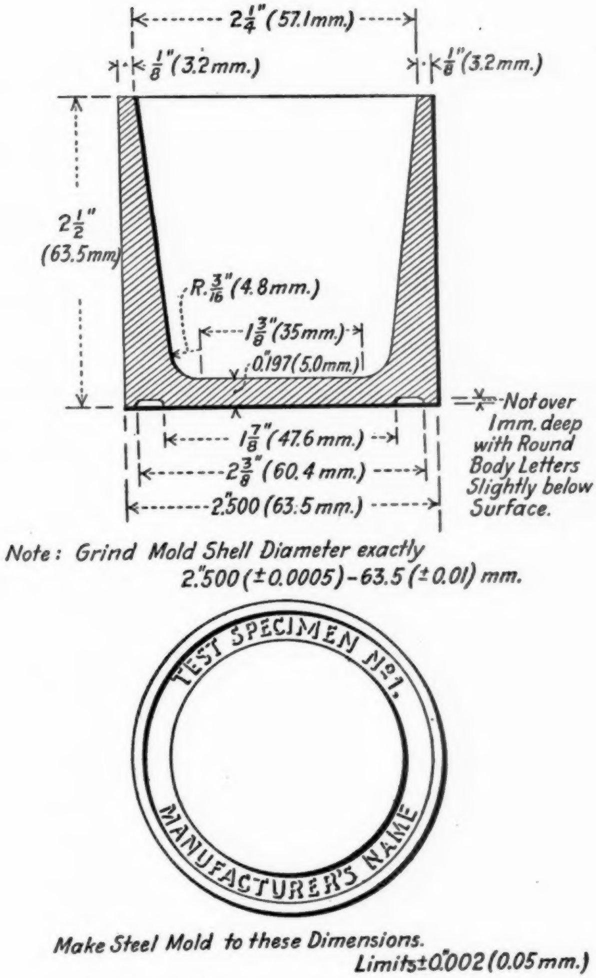


FIG. 4.—Test Specimen for Dielectric Strength (Specimen No. 1).

on the bottom extending to within about $\frac{1}{8}$ in. of the edge. Whenever it is impossible to puncture the specimen in air without arcing over the edge, it shall be deeply immersed in high grade transformer oil. On specimens which require a very high voltage to puncture it may be necessary to put a glass tube or shield over the wire leading to the inside in order to prevent breakdown over the surface of the oil between terminals. The testing voltage shall be raised from zero at a constant rate of approximately 1000 volts per second until puncture occurs.

(*b*) Ten specimens shall be punctured in the condition received at normal room temperature of about 21° C. (70° F.) in order to determine the uniformity of the molded material.

Five specimens shall be punctured after heating for one hour in an oven heated to 10° C. (18° F.) below the distortion point of the material as determined under Part (*C*), Sections 18 to 21. Puncture tests shall be made at this temperature with a permissible variation of ±5 per cent in degrees Centigrade. This test is intended to cover all molded materials which do not stand working temperatures above 125° C. (257° F.). Tests on materials which resist very high temperatures may be made above 125° C. (257° F.) when required.

Five specimens shall be punctured after they have had the rim immersed in melted paraffin for a depth of 1 in. and been entirely immersed in distilled water for 48 hours at normal room temperature of about 21° C. (70° F.). The surface of the specimen shall be wiped off with a dry cloth to remove all trace of excessive surface moisture and the puncture test shall be made in oil when necessary and at normal room temperature.

Report. 17. The results of tests shall be reported in the following order:

(*a*) The thickness of each specimen measured by micrometer in the direction perpendicular to its bottom surface, regardless of the path taken by the discharge. The thickness of all specimens shall be given in millimeters or mils.

(*b*) The puncture voltage of each test specimen and the average volts per millimeter or per mil as calculated from the average thickness of the specimens. Also give the maximum and minimum volts per millimeter or per mil.

(*c*) State the general character of the material tested with

regard to leakage, if any is observed, and give the puncture voltage in volts per unit of thickness withstood by the bottom section whenever puncture takes place on the side of the specimen. This indicates the dielectric strength under both favorable and unfavorable conditions of molding. Experience shows that very plastic materials which flow easily when hot always puncture through the bottom, while materials which do not flow readily will often puncture through the side walls of a specimen at some distance up from the bottom.

(*d*) Report the frequency of the electrical circuit from which the test voltage is obtained.

(*C*) *Thermal.*

DISTORTION UNDER HEAT.

18. The same test specimen shall be used for this test as required for the transverse strength test, Section 10, molded from a hard steel mold ground to the dimensions given in Fig. 3. **Specimen.**

19. A special apparatus shall be used for this test as shown in Fig. 5. The specimen is supported on steel supports 100 mm. (3.94 in.) apart with the load applied on top of the specimen vertically and midway between the supports, the same as for the transverse test. The machine shall be arranged to apply two different loads, 2.5 kg. (5.512 lb.) and 5 kg. (11.023 lb.). The specimen shall be placed in an air bath surrounded by an oil bath which is so arranged that its temperature may be raised gradually. The machine shall be so arranged that the deflection of the specimen at its center between the supports can be measured on a scale in millimeters or mils and shall be equipped with a thermometer so that the temperature of the specimen can be recorded at any time. The machine may be arranged to automatically shut off the heat and sound an alarm as soon as the required deflection is reached. **Apparatus.**

20. Three test specimens shall be tested in the condition in which they are received, starting at normal room temperature of 21° C. (70° F.) and increasing the temperature of the specimen gradually at the rate of approximately 1° C. every two minutes. **Method.**

The distortion point shall be considered the temperature at which the specimen has deflected 0.254 mm. (10 mils) at the center between the supports.

Report. 21. The results of the test shall be reported in the following order:

(*a*) The distortion point in degrees Centigrade and also in degrees Fahrenheit;

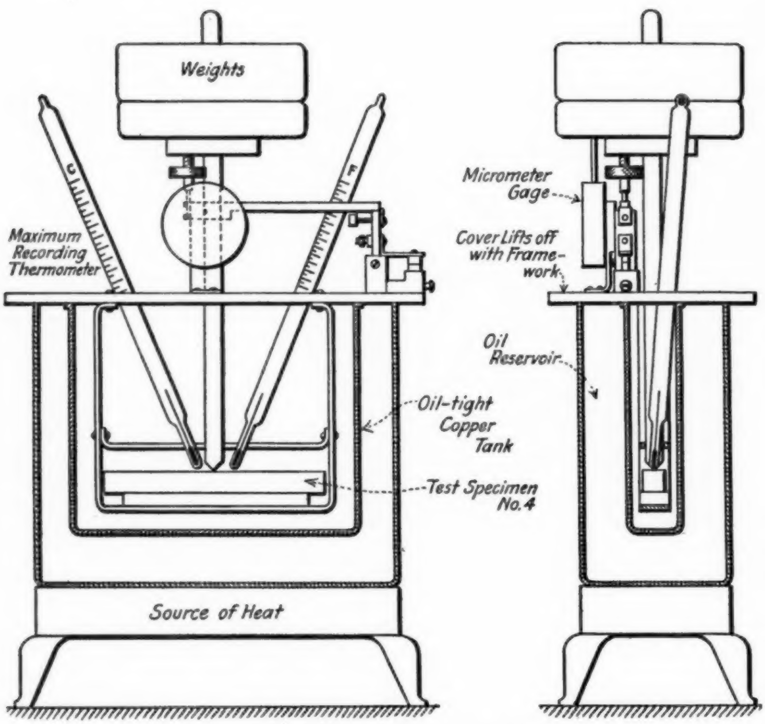


FIG. 5.—Machine for Temperature Tests.

(*b*) The length of time required for the specimen to deflect 0.254 mm. (10 mils).

(*c*) State any peculiar characteristics of the material as noted either during the test or after the specimen is removed from the machine.

(*d*) Plot a curve for each test specimen showing the time

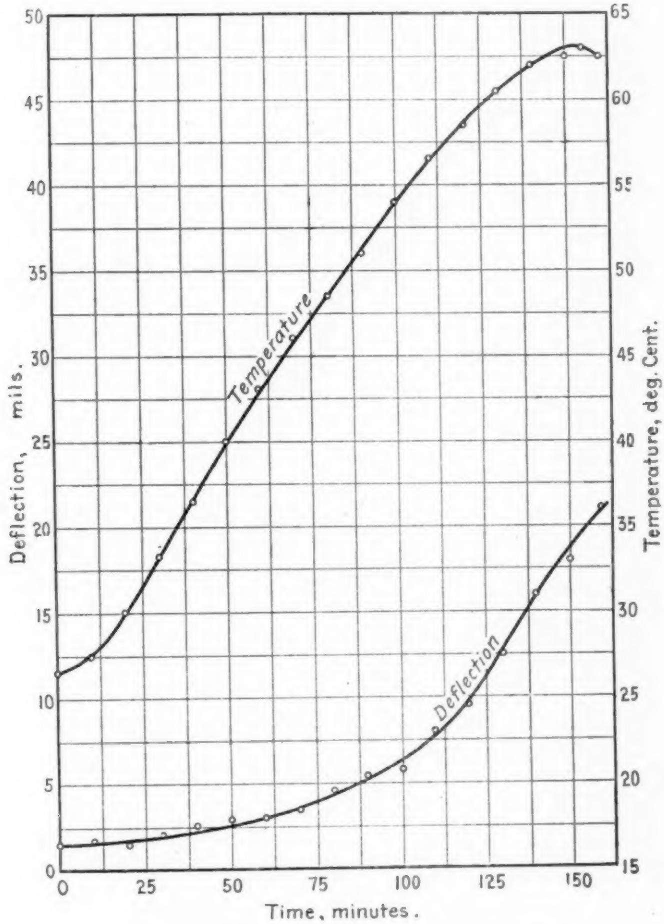


FIG. 6.—Typical Curve from Temperature Test.

in minutes horizontally and the amount of deflection and also the temperature at given intervals, using vertical ordinates as shown in Fig. 6.

(*D*) *Effect of Moisture.*

Specimen. 22. One-half of the standard test specimen shown in Fig. 1 shall be used for this test. This specimen shall be broken in half and all loose particles removed.

Apparatus. 23. Any good chemical balance may be used; also, a beaker of distilled water at normal room temperature of about 21° C. (70° F.), and an oven of any standard make, capable of maintaining a uniform temperature of 100° C. (212° F.), ± 5° C.

Method. 24. Weigh carefully three test specimens in the condition in which they are received. If the material softens readily at moderate temperatures, the specimens may be placed in a desiccator for 24 hours, or in an oven at a temperature of 50° C. (122° F.), ± 5° C., for 24 hours. For materials which do not soften readily the specimens shall be placed in an oven heated to 100° C. (212° F.), ± 5° C., for 24 hours. After drying, the specimens shall be weighed again at normal room temperature. Place the specimens in distilled water, wholly immersed, for 100 hours at normal room temperature. Remove the specimens at the end of 100 hours, wipe off all surface water with a dry cloth and weigh carefully.

Report. 25. The results of the test shall be reported in the following order:

(*a*) The original weight of each specimen;

(*b*) The dry weight of each specimen;

(*c*) The saturated weight in grams of each specimen after immersion for 100 hours;

(*d*) The percentage of moisture contained in each test specimen as received, and the percentage of moisture absorbed during 100 hours, taking the dry weight as 100 per cent. Give the average for the three specimens.

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TENTATIVE METHOD

FOR

DETERMINATION OF SOFTENING POINT OF BITUMINOUS MATERIALS OTHER THAN TAR PRODUCTS.[1]

Serial Designation: D 36 – 16 T.

This method is issued under the fixed designation D 36; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1916.

1. The Ring-and-Ball method shall be used. **Definition.**

2. The apparatus shall consist of a brass ring 15.875 mm. ($\frac{5}{8}$ in.) in diameter, 6.35 mm. ($\frac{1}{4}$ in.) deep, 2.38125 mm. ($\frac{3}{32}$ in.) wall, suspended 25.40 mm. (1 in.) above bottom of beaker; a steel ball 9.525 mm. ($\frac{3}{8}$ in.) in diameter, weighing between 3.45 and 3.50 g.; a standardized thermometer; a glass beaker, approximately 600-cc. capacity. (See Fig. 1.) **Apparatus.**

3. Carefully melt the sample and fill the ring with the material to be tested. Remove any excess. Place the ball in the center of the ring and suspend in the beaker containing approximately 400 cc. of water at a temperature of 5° C. (41° F.). Arrange the thermometer bulb within $\frac{1}{2}$ in. of the sample and at the same level. Apply heat *uniformly* over bottom of the beaker in quantity sufficient to raise the temperature 5° C. (9° F.) per minute. Record the temperature at starting the test **Method.**

[1] Criticisms of this Tentative Method are solicited and should be directed, preferably before January 1, 1919, to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

and every minute thereafter until the test is completed. The rate of heating is very important. The softening point is the temperature at which the specimen has dropped 1 in. Suc-

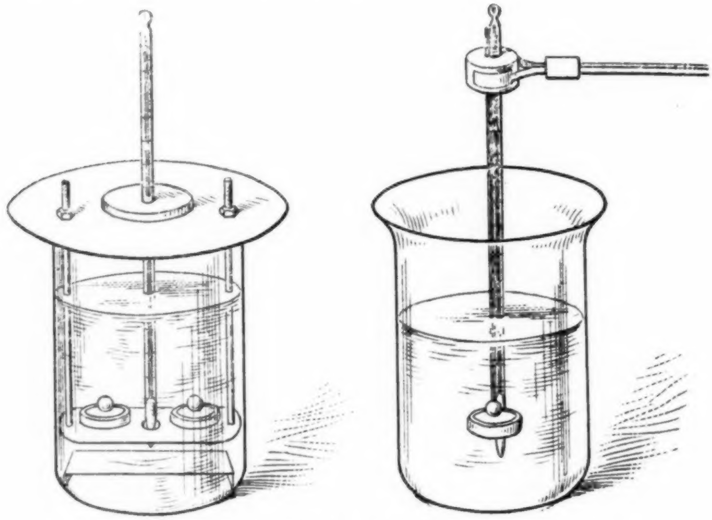

FIG. 1.—Apparatus for Determination of Softening Point.

cessive tests should average within 3° C. For temperatures above 9° C., glycerin shall be used instead of water.

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TENTATIVE GENERAL METHODS FOR TESTING COTTON FABRICS.[1]

Serial Designation: D 39 - 18 T.

These methods are issued under the fixed designation D 39; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1915; REVISED, 1916, 1918.

1. The following General Methods are intended to be applicable for testing cotton fabrics. Where a material requires special treatment, specific methods will be described as they are developed for that material and such special tests shall have precedence over the general method.

I. CONDITION.

Dry Condition

2. The dry condition of cotton fabric shall be understood to be absolute dryness obtained by material placed in a ventilated drying oven maintained at a temperature of 105 to 110° C. (221 to 230° F.) and dried to constant weight as determined by two consecutive weighings without removal

[1] Criticisms of these Tentative Methods are solicited and should be directed, preferably before January 1, 1919, to Mr. G. B. Haven, Chairman of Committee D-13 on Textile Materials, Massachusetts Institute of Technology, Cambridge, Mass.

from the oven, to be taken not less than ten minutes apart, and to show a further loss of not more than 0.1 per cent of the previous weighing.

Standard Condition. 3. The standard condition of cotton fabric shall be understood to be the condition in which it contains 6.5 per cent of its dry weight of moisture.

II. TEST METHODS.

(*A*) *Length.*

Length. 4. The length of a roll or piece shall be determined by running the cloth over a measuring drum of known circumference, from which the yardage is registered by a dial or counter driven by a chain or other positive or non-slip mechanism. Just enough uniform tension[1] is to be used on the cloth to keep it running flat and true.

(*B*) *Width.*

Width. 5. (*a*) The width of a roll or piece shall be determined at five different places uniformly distributed along the full length of the roll or piece, and may be determined at the same time as the total length.

(*b*) The average of the five measurements shall be the width.

(*C*) *Weight.*

Normal Weight. 6. (*a*) *Preferred Method.*—The net weight of the roll or piece from which covering and binding have been removed shall be determined. The net weight of the roll or piece divided by its superficial area in square yards shall be taken as the normal net weight per square yard.

(*b*) *Alternative Method.*—Three samples of known area, to contain not less than 4 sq. in. each, shall be stamped (preferably cut with a steel die) from one end of the roll or piece and quickly weighed. The normal square yard weight shall be computed from the average weight of these three samples.

Dry Weight. 7. (*a*) *Preferred Method.*—For the determination of dry weight two test specimens of approximately equal area, each

[1] It has been suggested that a uniform tension of 2.5 times the weight of five running yards of the fabric will be sufficient to keep the fabric flat and preserve a proper relation for comparison of different fabrics. Invitation is extended to report to the committee the results of such tests upon different fabrics.

not less than 4 in. in length and of the entire width of the fabric, shall be cut one from each end of the roll or piece. The one from the outside end of the roll shall be taken as soon as the wrapping is removed and the one from the inner end of the roll as soon as the inner end of the roll has been reached in running the roll. The two samples shall be taken as soon as possible. These samples shall be placed in a dry air-tight container, the weight of which has been previously determined, and carefully weighed therein and then removed (check weight being made on container), the net weight calculated and the sample dried to constant weight in manner described in Section 2. The difference between the original weight of sample and the dry weight is the loss of moisture which when computed as percentage of the dry weight is the percentage regain of the material. The dry weight per square yard is then obtained from the normal weight per square yard as obtained in Section 6 (*a*), as follows:

$$\frac{\text{Normal weight per sq. yd.} \times 100}{100 + \text{percentage regain}} = \text{Dry weight per square yard.}$$

(*b*) *Alternative Method.*—From one end of the roll or piece five specimens, each 3 by 4.32 in., representing 0.01 sq. yd., shall be stamped (preferably cut with a steel die). Two specimens shall be cut near the selvages, one at the center, and the other two between the selvages and the center. These five specimens, with a total area equal to 0.05 sq. yd., shall be placed in the wire basket of a ventilated drying oven. The basket shall be so constructed with partitions, not less than $\frac{1}{4}$ in. apart, that the specimens may stand on edge. The specimens shall then be dried to bone dryness as described in Section 2. The combined weight of these specimens after drying represents the dry weight of 0.05 sq. yd. of the fabric, and the dry weight per square yard of the roll or piece is obtained by multiplying the above quantity by 20.

8. If by the first tests the fabric fails to meet the specifications a second swatch shall be taken as follows: If the roll or piece is a complete warp, the second swatch shall be cut from the center of the roll or piece. If the roll or piece is a part warp, the second swatch shall be taken not less than $1\frac{1}{2}$ yd. from the other end. **Retest.**

Moisture Content and Regain.

9. The difference between the normal weight of the fabric, Section 6, and the dry weight, Section 7, is the amount of moisture present.

(*a*) When computed as percentage of the normal weight this is the *Moisture Content* of the material.

(*b*) When computed as percentage of the dry weight, this is the *Moisture Regain* of the material.

(*D*) *Number of Threads per Inch.*

Number of Threads per Inch.

10. (*a*) The number of threads per inch or count of the fabric shall be determined by counting a space of not less than 1 in. in at least five different places in the roll or piece.

(*b*) The average of the five determinations shall be the count.[1]

(*E*) *Thickness.*

Thickness.

11. (*a*) The thickness shall be measured by an automatic micrometer which presses upon at least 0.5 sq. in. of the fabric with a uniform constant pressure, and which is so mounted as to make measurements 6 in. from the selvage.

(*b*) At least ten measurements at different portions of the roll or piece shall be made, and the average shall be the thickness of the fabric.

(*F*) *Strength.*

Tensile Strength.

12. Tensile strength tests shall be made by one of the four methods described as follows in detail, and fabrics shall be tested by the method shown for the classification under which they fall. In each case the results shall be recorded separately for warp and filling.

For the determination of tensile strength a swatch of the length specified in Table I shall be cut the entire width of the cloth and test specimens shall be cut from this swatch according to the respective diagrams shown at the bottom of Table I.

Two methods of determining the tensile strength shall be recognized:

[1] For tire fabric used for carcass building the number of threads per inch shall be determined by counting a space of 10 in. in at least five different places in the roll or piece, and the average of the five determinations shall be the count.

(*a*) *Strip Test* (*Fig. 1*).—Under this method a long narrow strip of the fabric shall be clamped at each end by the jaws of the testing machine and strained to the point of rupture. **Strip Test.**

(*b*) *Grab Test* (*Fig. 2*).—Under this method the testing machine jaws, each of definite width, shall be made to reach into the body of a rectangular piece of fabric and shall be clamped a definite distance apart. Care shall be taken that the same set of threads are embraced by both pairs of jaws. The specimen shall then be strained to the point of rupture. **Grab Test.**

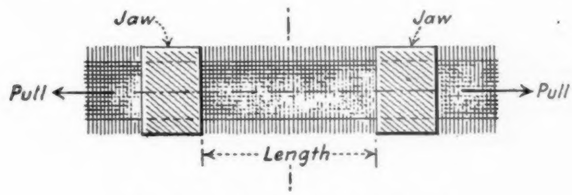


FIG. 1.—Illustration of Strip Test.

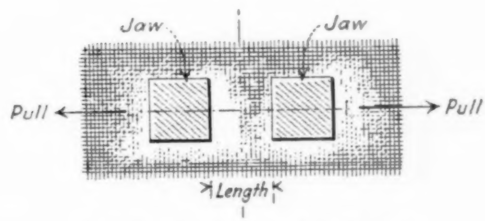


FIG. 2.—Illustration of Grab Test.

13. *Correction for Standard Moisture Regain.*—When it is desired to test tension specimens in the natural state in which they are cut from the roll or piece, the following method shall be employed to reduce the tensile strength found to the common basis of an assumed Standard Moisture Regain equal to 6.5 per cent of the bone-dry weight: **Correction for Moisture.**

(*a*) After preparing the specimens for the testing machine, those cut from the warp and those from the filling shall be weighed each in a separate batch under the natural moisture conditions which obtain at the time in the testing room.

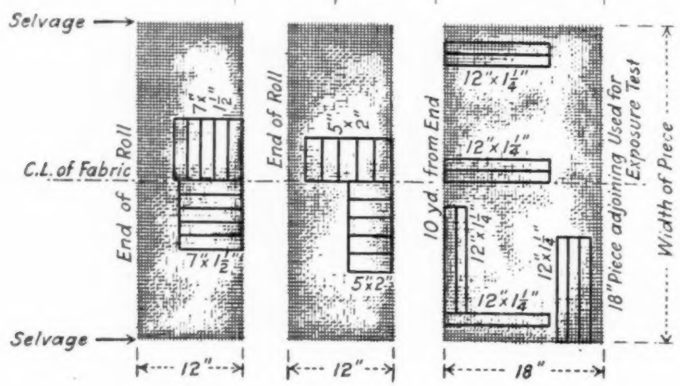
(*b*) The specimens shall then be tested immediately, in as rapid succession as possible, by the method specified in Table II.

(*c*) After rupture the broken specimens (entire) shall be placed in the basket of an oven and dried as defined in Section 2.

(*d*) The total warp and filling specimens shall be grouped each by themselves, forming two batches. The aggregate dry weight of the warp and filling specimens shall thus be

TABLE I.—TENSILE STRENGTH TEST METHODS.

Method No.	1 Strip Method.	2 Grab Method.	3 Strip Method.	4 Single Strand.
Dimensions of specimens, in.	7 by $1\frac{1}{2}$	5 by 2	12 by $1\frac{1}{4}$	..
Width ravelled to — in.	1	..	1	..
Min. width of bottom or back jaws, in.	$1\frac{1}{2}$	2	$1\frac{1}{2}$	..
Width of top or front jaws, in.	$1\frac{1}{2}$ (min.)	1	$1\frac{1}{2}$ (min.)	..
Distance between jaws, in.	3	1	8	10
Speed of separation of jaws, in. per min.	20	12	12	20
Number of specimens each, warp and filling	5	5	5	20 strand



No. 1. No. 2. No. 3.

NOTES.—1. When material is less than 24 in. wide, the swatch shall be cut 24 in. long and the test specimens shall be laid out in such a manner that no part of any specimen shall come within 2 in. of either selvage.

2. When the specified number of threads or picks per inch is in fraction, the number of threads broken shall include the fraction as a full thread.

obtained and the Moisture Regain at the time of the test determined.

(*e*) The following formula shall then be applied, based upon the assumption that the Standard Moisture Regain of

TABLE II.—TENSILE STRENGTH: TEST METHOD CLASSIFICATION.

Name of Fabric.	Test Method No.	Humidity Conditions.
TIRE FABRICS, including		
Carcass building fabric	1	Test specimens shall be tested in a dry condition as defined in Section 2. They shall be taken one at a time from the drying oven and broken in the testing machine within 30 seconds from the time of removal from the oven.
Chafing strip	1	
Breaker strip	1	
Cord fabric	4	
DUCKS, including		
Hose duck	2	(a) Specimens may be broken in dry condition as specified above for tire fabrics, such tests to be captioned, "Tested Bone Dry." (b) Specimens may be tested in their natural condition as taken from the roll or piece and corrected for the moisture present by the method of Section 12, such tests to be captioned, "Corrected for Standard Moisture Regain."
Belt duck	2	
Tent duck	2	
Army duck	2	
Enamelling duck	2	
Sail duck	2	
Numbered duck	2	
DRILLS	2	
SHEETINGS	2	
OSNABURG	2	
COUTILS	2	
BALLOON CLOTH[1]	1	
WING FABRIC[2]	3	Exposed before testing for at least two hours in an atmosphere of 65 per cent relative humidity and 70° F. and tested in this atmosphere.

[1] Balloon cloth shall be tested on machine of the inclination balance type with maximum capacity of 400 lb.

[2] The elongation of wing fabric shall be observed for each specimen when subjected to loads of 10 lb., 20 lb., and 70 lb. Wherever possible autographic records shall be taken.

NOTE.—Fabrics not included in the above list will be given a test method classification by Committee D-13 on application of those interested.

manufactured cotton is 6.5 per cent of the dry weight, that the Actual Percentage Regain is between the limits of 3 and 6.5 per cent of the dry weight, and that for 1 per cent of moisture regain there is an increase of 6 per cent in the tensile strength of the fabric.

$$\begin{array}{c}\text{Tensile Strength corrected}\\ \text{to Standard Moisture Regain}\end{array} = \frac{(\text{Tensile Strength from machine reading}) \times 139}{100 + (6 \times \text{Actual Percentage Regain})}$$

Example.—A specimen of fabric broken under natural conditions gave a tensile strength of 294 lb. as read from the machine dial. By weighing before and after drying the specimen was found to contain a Moisture Regain equal to 3 per cent of the bone-dry weight. The tensile strength corrected to a common basis of 6.5 per cent Moisture Regain would therefore be

$$\text{Tensile Strength corrected} = \frac{294 \times 139}{100 + (6 \times 3)} = 346 \text{ lb.}$$

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE DEFINITIONS AND RULES GOVERNING THE PREPARATION OF MICROGRAPHS OF METALS AND ALLOYS.[1]

Serial Designation: E 2 - 18 T.

These definitions and rules are issued under the fixed designation E 2; the final number indicates the year of original issue, or in the case of revision, the year of last revision.

ISSUED, 1917; REVISED, 1918.

I. STANDARD MAGNIFICATIONS.

General Use. 1. The standard magnifications for general use in making micrographs, expressed in diameters, shall be as follows:

10, 25, 50, 75, 100, 150, 250, 500, 750, 1000, 1500.

Ferrous Metals. 2. (*a*) The standard magnifications for making micrographs of steel and ferrous materials shall be:

50, 100, 250, 500, 1000.

(*b*) For general use in Society reports, and for showing grain size, a magnification of 100 diameters shall be used.

Non-Ferrous Metals. 3. (*a*) The standard magnifications for making micrographs of non-ferrous metals shall be:

10, 25, 50, 75, 100, 150, 250.

[1] Criticisms of these Tentative Definitions and Rules are solicited and should be directed, preferably before January 1, 1919, to Mr. W. H. Bassett, Chairman of Committee E-4 on Magnification Scales for Micrographs, American Brass Co., Waterbury, Conn.

(*b*) For general use in Society reports, and for showing grain size of copper and copper-zinc alloys, a magnification of 75 diameters shall be used.

For copper-nickel and copper-nickel-zinc alloys, a magnification of 150 diameters shall be used.

(*c*) For alloys of lead, tin and antimony, including those containing small percentages of copper, magnifications of 50 and 250 shall be used.

Reproduction of Micrographs.

4. (*a*) Reproductions of micrographs in publications shall be made of exact standard magnifications.

(*b*) If micrographs submitted for publication are not of standard magnification, they shall be enlarged or reduced to the nearest standard size. The actual magnification appearing in print shall be stated under the micrograph. See Paragraph (*d*).

(*c*) To facilitate the reproduction, authors should be advised that their micrographs should be of proper size to fit the printed page, and in order to conserve space that micrographs be printed in the form of squares.

(*d*) With each micrograph shall be printed an explanatory title, together with actual magnification, etching medium, treatment, etc., indicating what the author intends to show, so that it will not be necessary to search the text for general information. With micrographs at magnifications of approximately 500 diameters and above, the numerical aperature of the objective and the type of illuminator shall be given.

II. LENSES.

Lenses.

5. For obtaining the magnifications recommended, the following types of lenses are suggested as suitable for general commercial work:

(*a*) For magnifications from 20 to 50: A lens of the microplanar or microtessar type (*e. g.*, approximately 35-mm. focal length); no ocular is required.

(*b*) For magnifications from 30 to 75: A 32-mm. objective with Huyghens ocular (approximately ×5).

(*c*) For magnifications from 75 to 150: A 16-mm. objective with Huyghens ocular (approximately ×5).

(*d*) For magnifications from 250 to 500: A 4-mm. objective (preferably apochromatic) with projection ocular.

Directions.

6. (*a*) All objectives should be corrected for uncovered objects.

(*b*) In using one of the lens combinations given above, the length of the camera bellows may be adjusted to give the exact magnification desired.

It should be borne in mind, however, that increasing the magnification by increasing the length of the camera bellows adds nothing to the detail of the micrograph. This depends mainly upon the resolving power of the objective used.

(*c*) The magnification shall be determined by accurately measuring the image of a stage micrometer scale, and not by estimation from lens combinations, or microscope or camera adjustments.

III. GRAIN SIZE.

Definition of Grain.

7. (*a*) *Alloys Consisting of but One Type of Crystals* (*e. g.*, copper, alpha brass, etc.): In counting individual grains the original crystal, including the twinned layers, shall be called one grain.

(*b*) *Alloys Consisting of Two Metallographic Components* (*e. g.*, steels, Muntz metal, etc.): The original grain which has given rise to the aggregation of the two components shall be taken as the unit when determinable and the individual component in other cases.[1] When grain size is included in actual specifications, the term should always be defined in such specifications.

Method of Measurement of Grain Size.

8. For measuring grain size, two methods are recommended depending upon the condition of the material:

(*a*) *For Material in which the Grains are Equi-axed* (*e. g.*, most metals in the cast and in the annealed state): The planimetric method as modified by Jeffries[2] is recommended for use as being very accurate and rapid. It is recommended that the circular area used should always include at least 50 grains.

(*b*) *When the Grains are not Equi-axed* (*e. g.*, in strained materials): Heyn's intercept method should be used, the average grain size being determined by counting the number

[1] See U. S. Navy Specifications, 49-S-2-c, p. 7.
[2] See Note on pp. 719–721.—ED.

of grains at a given magnification along a line of known length on two axes at right angles to each other, one axis being parallel to the direction of rolling. In some cases a third count along a line perpendicular to the other two may be desirable. This will necessitate the preparation of another polished surface.

Numerical Expression of Grain Size.

9. The grain size as determined by the planimetric method, Section 8 (*a*), should be expressed as the number of grains per unit area (square inch or square centimeter). This may also, but less preferably so, be expressed as the average grain area; or the average linear dimension of the grain may be given. The grain size as determined by the intercept method, Section 8 (*b*), should be expressed by giving the average number of grains per linear unit in the two directions; or the average number per unit area together with the ratio of length to breadth of grain (L/B) may be given.

Use of Grain Size in Specifications.

10. If grain size is to be included in specifications, it should be expressed as the maximum or minimum allowable as determined above. It is recommended that only in extreme cases should grain size be made the sole basis of rejection of material.

NOTE

JEFFRIES' METHOD FOR GRAIN-SIZE MEASUREMENTS.[1]

A circle 79.8 mm. in diameter is drawn on the rough side of a ground-glass screen, the center of the circle being near the center of the rectangular section of the screen. This ground glass is mounted in a frame which fits a metallographic camera, the smooth side of the glass being on the outside. When the image of the specimen for grain-size determination is focused on the screen, the circle will be plainly visible and its circumference should be well within the image.

When the image is properly focused the grains intersected by the circumference of the circle are checked and counted. Since the check marks must be made on the smooth side of the glass, a soft red pencil, such as is used in laboratories for marking beakers and flasks, will be found satisfactory. The marks used to indicate the boundary grains are usually short, straight lines intersecting the circumference of the circle and perpendicular to it. The completely included grains are next checked and counted, after which the red marks are erased from the glass with a dry cloth. The specimen can then be moved and other measurements made as desired.

[1] This method has been condensed from the paper by Mr. Zay Jeffries appearin *Metallurgical and Chemical Engineering*, Vol. XVIII, p. 185 (1918).

One-half the number of grains intersected by the circumference of the circle, added to the number of completely included grains, gives the number of equivalent whole grains within the circle. If the equivalent number of whole grains within the circle measured at a certain magnification be multiplied by the number in the third column of Table I opposite the magnification used, the product will be the number of grains per square millimeter.

TABLE I.

Magnification Used (= m).	Diameter of Circle, mm.	Multiplier to Obtain Grains per Square Millimeter (= f).
Full size	79.8	0.0002
10	"	0.02
25	"	0.125
50	"	0.5
75[a]	"	1.125
100	"	2.0
150	"	4.5
200	"	8.0
250	"	12.5
300	"	18.0
500	"	50.0
750	"	112.5
1000	"	200.0
1500	"	450.0
2000	"	800.0

[a] At 75 diameters, if a circle 84.5 mm. in diameter, or a rectangle having an area of 5625 sq. mm. is used, the factor f becomes unity.

A circle 79.8 mm. diameter has an area of 5000 sq. mm. If it is desired to use a rectangle of the same area in place of a circle for the determination, convenient sizes are given as follows:

70.7	by	70.7	mm.
65	"	77	"
60	"	83.3	"
55	"	91	"
50	"	100	"

Since each of these rectangles has an area of about 5000 sq. mm., the multipliers given in Table I can be used for any one of them, or any other rectangle having an area of 5000 sq. mm. To make a grain-size determination with a rectangular in place of a circular area, the grains intersected by the periphery of the rectangle should be counted, one-half the number added to the completely included grains and the result will be the number of equivalent whole grains within the rectangle. If the determination is made at one of the magnifications given in Table I, the number of grains per square millimeter can be obtained by multiplying the equivalent number of whole

grains within the area by the multiplier (f) opposite the magnification used. The rectangle could be used on a ground glass as described above for the circle, or it could be used on a micrograph.

Some metallographists prefer to refer to the grain size in terms of the diameter of the average grain in millimeters, or the area of the average grain in μ^2. The following simple formulas will be found helpful in these cases:

w = number of boundary grains;
z = number of completely included grains;
x = equivalent number of whole grains in 5000 sq. mm. (circle 79.8 mm. in diameter or rectangle having area of 5000 sq. mm.);
m = magnification used;
f = multiplier to obtain number of grains per square millimeter;
n = number of grains per square millimeter;
d = diameter of average grain in millimeters;
a = area of average grain in μ^2.

$$x = \tfrac{1}{2} w + z$$

$$f = \frac{m^2}{5000}$$

$$n = fx$$

$$d = \frac{1}{\sqrt{n}}$$

$$a = \frac{1,000,000}{n}$$

LIST OF TENTATIVE STANDARDS

PUBLISHED BY THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

The term Tentative Standards is applied to a proposed Standard which is printed in the Proceedings for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action towards the adoption of such Tentative Standards by formal action of the Society.

These Tentative Standards are all copyrighted in the name of the American Society for Testing Materials. Permission to reprint any of these Tentative Standards can be obtained only from the Executive Committee on application to the Secretary-Treasurer.

The designations A 67, A 70, etc., of the Tentative Standards are fixed; they follow in numeric sequence the designations of the Standards, and are retained when a Tentative Standard is adopted as Standard. The final number, as 18, indicates the year of original issue, or in the case of revision, the year of last revision. The letter "T" is appended to the designation of all Tentative Standards. The serial designations of Tentative Standards which have for any reason not been adopted as standard, and have been discontinued, are permanently dropped. In ordering Tentative Standards, the complete serial designations should be stated, thus, A 67–18 T, etc.

A. FERROUS METALS.

STEEL.

TENTATIVE SPECIFICATIONS.

A 67–18 T. For Steel Tie Plates.

Proposed in 1916 (Vol. XVI, Part I, pp. 414–417).
Revised in 1917 (Vol. XVII, Part I, pp. 84 and 541–545).
Revised in 1918 (Vol. XVIII, Part I, pp. 103, 104, 105).

A 70–18 T. For Boiler and Firebox Steel for Stationary Service.

Proposed in 1916 (Vol. XVI, Part I, pp. 429–433).
Revised in 1917 (Vol. XVII, Part I, pp. 110 and 557–561).
Revised in 1918 (Vol. XVIII, Part I, pp. 131–132).

A 71–17 T. For Carbon Tool Steel.

Proposed in 1917 (Vol. XVII, Part I, pp. 562–563).

A 76–18 T. For Low-Carbon-Steel Track Bolts.

Proposed in 1918 (Vol. XVIII, Part I, p. 129).

A 77–18 T. For Electric Cast Steel Anchor Chain.

Proposed in 1918 (Vol. XVIII, Part I, pp. 112–113, 133–134).

CAST IRON.

TENTATIVE SPECIFICATIONS.

A 75–18 T. For Malleable Castings.[1]

Proposed in 1917 (Vol. XVII, Part I, pp. 133 and 582–584).
Revised in 1918 (Vol. XVIII, Part I, pp. 157, 29).

B. NON-FERROUS METALS.

TENTATIVE SPECIFICATIONS.

B 17–18 T. For Non-Ferrous Alloys for Railway Equipment in Ingots, Castings, and Finished Car and Tender Bearings.

Proposed in 1917 (Vol. XVII, Part I, pp. 610–614).
Revised in 1918 (Vol. XVIII, Part I, pp. 251–253, 260–261).

B 19–18 T. For Cartridge Brass.

Proposed in 1918 (Vol. XVIII, Part I, p. 247).

B 20–18 T. For Cartridge Brass Disks.

Proposed in 1918 (Vol. XVIII, Part I, p. 247).

B 21–18 T. For Naval Brass Rods for Structural Purposes.

Proposed in 1918 (Vol. XVIII, Part I, p. 247).

B 22–18 T. For Bronze Bearing Metals for Turntables and Movable Railroad Bridges.

Proposed in 1918 (Vol. XVIII, Part I, pp. 249–250).

B 23–18 T. For White Metal Bearing Alloys (known commercially as "Babbitt Metal").

Proposed in 1918 (Vol. XVIII, Part I, p. 250).

[1] When proposed in 1917, these specifications were entitled "Tentative Specifications for Railroad Malleable-Iron Castings."

B 24–18 T. For Aluminum Ingots for Remelting and for Rolling.

Proposed in 1918 (Vol. XVIII, Part I, p. 260).

B 25–18 T. For Aluminum Sheet.

Proposed in 1918 (Vol. XVIII, Part I, p. 260).

B 26–18 T. For Light Aluminum Casting Alloys.

Proposed in 1918 (Vol. XVIII, Part I, p. 260).

TENTATIVE METHODS.

B 18–17 T. For Chemical Analysis of Alloys of Lead, Tin, Antimony and Copper.

Proposed in 1917 (Vol. XVII, Part I, pp. 622–629).

B 27–18 T. For Chemical Analysis of Manganese Bronze.

Proposed in 1918 (Vol. XVIII, Part I, p. 254).

B 28–18 T. For Chemical Analysis of Gun Metal.

Proposed in 1918 (Vol. XVIII, Part I, p. 254).

C. CEMENT, LIME, GYPSUM, AND CLAY PRODUCTS.

TENTATIVE SPECIFICATIONS.

C 9–16 T. Specifications and Tests for Compressive Strength of Portland-Cement Mortars.

Proposed in 1916 (Vol. XVI, Part I, pp. 590–593).
To be added, when adopted, to the Standard Specifications and Tests for Portland Cement (Serial Designation: C 9–17).

C 13–18 T. For Clay Sewer Pipe.

Proposed in 1917 (Vol. XVII, Part I, pp. 634–646).
Revised in 1918 (Vol. XVIII, Part I, pp. 274, 276–277).

C 14–18 T. For Cement Concrete Sewer Pipe.

Proposed in 1917 (Vol. XVII, Part I, pp. 647–658).
Revised in 1918 (Vol. XVIII, Part I, pp. 274, 278–279).

C 15–17 T. For Required Safe Crushing Strengths of Sewer Pipe to Carry Loads from Ditch Filling.

Proposed in 1917 (Vol. XVII, Part I, pp. 659–660).

C 6–17 T. For Masons' Hydrated Lime.

Proposed in 1917 (Vol. XVII, Part I, pp. 661–664).

To replace, when adopted, the Standard Specifications for Hydrated Lime (Serial Designation: C 6–15).

TENTATIVE TESTS.

C 16–18 T. For Refractory Materials under Load at High Temperatures.

Proposed in 1917 (Vol. XVII, Part I, pp. 665–668).
Revised in 1918 (Vol. XVIII, Part I, pp. 290–291, 292).

C 17–17 T. For Slagging Action of Refractory Materials.

Proposed in 1917 (Vol. XVII, Part I, pp. 669–670).

TENTATIVE METHODS.

C 18–18 T. For Ultimate Chemical Analysis of Refractory Materials.

Proposed in 1917 (Vol. XVII, Part I, pp. 671–678).
Revised in 1918 (Vol. XVIII, Part I, pp. 287–289, 292).

C 20–18 T. For Determination of Porosity and Permanent Volume Changes in Refractory Materials.

Proposed in 1918 (Vol. XVIII, Part I, pp. 290, 292).

TENTATIVE DEFINITIONS.

C 11–16 T. Of Terms Relating to the Gypsum Industry.

Proposed in 1916 (Vol. XVI, Part I, pp. 452–471).

TENTATIVE RECOMMENDED PRACTICE.

C 12–17 T. For Laying Sewer Pipe.

Proposed in 1915 (Vol. XV, Part I, pp. 163-164; 1915 Year-Book, pp. 553–558).
Revised in 1916 (Vol. XVI, Part I, pp. 472–478).
Revised in 1917 (Vol. XVII, Part I, pp. 293 and 701–703).

D. MISCELLANEOUS MATERIALS.

TENTATIVE SPECIFICATIONS.

Preservative Coatings.

D 51–18 T. For Foots Permissible in Properly Clarified Pure Raw Linseed Oil from North American Seed.

Proposed in 1918 (Vol. XVIII, Part I, pp. 297–298).

Timber.

D 23–16 T. For Selected Structural Douglas Fir Bridge and Trestle Timbers.

Proposed in 1916 (Vol. XVI, Part I, pp. 479–482).

D 24–15 T. For Southern Yellow-Pine Timber to be Creosoted.

Proposed in 1915 (Vol. XV, Part I, pp. 365–366; 1915 Year-Book, pp. 563–564).

D 25–15 T. For Southern Yellow-Pine Piles and Poles to be Creosoted.

Proposed in 1915 (Vol. XV, Part I, pp. 365–366; 1915 Year-Book, pp. 565–566).

D 52–18 T. For Wooden Paving Blocks for Exposed Pavements.

Proposed in 1918 (Vol. XVIII, Part I, pp. 336–338, 339).

Waterproofing.

D 40–17 T. For Asphalt for Use in Damp-proofing and Waterproofing.

Proposed in 1917 (Vol. XVII, Part I, pp. 712–715).

D 41–17 T. For Primer for Use with Asphalt for Use in Damp-proofing and Waterproofing.

Proposed in 1917 (Vol. XVII, Part I, p. 716).

D 42–17 T. For Coal-Tar Pitch for Use in Damp-proofing and Waterproofing.

Proposed in 1917 (Vol. XVII, Part I, pp. 717–720).

D 43–17 T. For Creosote Oil for Priming Coat with Coal-Tar Pitch for Use in Damp-proofing and Waterproofing.

Proposed in 1917 (Vol. XVII, Part I, pp. 721–722).

Shipping Containers.

D 44-17 T. For Canned Foods Boxes, Nailed and Lock-Corner Construction.

Proposed in 1917 (Vol. XVII, Part I, pp. 723-729).

D 45-17 T. For Canned Foods Boxes, Wirebound Construction.

Proposed in 1917 (Vol. XVII, Part I, pp. 730-731).

Rubber Products.

D 27-16 T. For Insulated Wire and Cable: 30-per-cent Hevea Rubber.

Proposed in 1916 (Vol. XVI, Part I, pp. 492-517).

D 53-18 T. For Rubber Belting for Power Transmission.

Proposed in 1918 (Vol. XVIII, Part I, pp. 354-356).

D 54-18 T. For Steam Hose.

Proposed in 1918 (Vol. XVIII, Part I, pp. 354, 356).

TENTATIVE TESTS.

D 28-18 T. For Flash Point of Paint Thinners other than Turpentine.

Proposed in 1918 (Vol. XVIII, Part I, pp. 297-298).
To be added, when adopted, to the Standard Tests for Paint Thinners other than Turpentine (Serial Designation: D 28-17).

D 55-18 T. For Determination of Apparent Specific Gravity of Sand, Stone, and Slag Screenings, and Other Fine Non-Bituminous Highway Materials.

Proposed in 1918 (Vol. XVIII, Part I, pp. 328, 330).

D 48-17 T. For Molded Insulating Materials.

Proposed in 1917 (Vol. XVII, Part I, pp. 778-790).

TENTATIVE METHODS.

D 36-16 T. For Determination of Softening Point of Bituminous Materials other than Tar Products.

Proposed in 1916 (Vol. XVI, Part I, pp. 549-550).

D 39-18 T. For Testing Cotton Fabrics.[1]

Proposed in 1915 (Vol. XV, Part I, pp. 440-442; 1915 Year-Book, pp. 574-578).
Revised in 1916 (Vol. XVI, Part I, pp. 572-578).
Revised in 1918 (Vol. XVIII, Part I, pp. 363-364).

E. MISCELLANEOUS SUBJECTS.

TENTATIVE DEFINITIONS.

E 2-18 T. Definitions and Rules Governing the Preparation of Micrographs of Metals and Alloys.

Proposed in 1917 (Vol. XVII, Part I, pp. 838-841).
Revised in 1918 (Vol. XVIII, Part I, pp. 425-427).

[1] This tentative method was revised in 1918, and in revised form replaced the following Tentative Tests: For Automobile Tire Fabrics (D 31-16 T), proposed in 1916 (Vol. XVI, Part I, pp. 531-532); for Cotton Fabrics for Use in Hose, Belting and Similar Articles (D 32-16 T), proposed in 1916 (Vol. XVI, Part I, p. 533); for Cotton Fabrics for Use in Bags and Bagging Material (D 33-16 T), proposed in 1916 (Vol. XVI, Part I, pp. 534-535).

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MEMBERS OF EXECUTIVE COMMITTEE

(Term Expiring in 1919)

J. A. CAPP
W. F. M. GOSS
W. M. KINNEY
C. D. YOUNG

(Term Expiring in 1920)

GUILLIAEM AERTSEN
GEORGE K. BURGESS
G. B. HECKEL
K. W. ZIMMERSCHIED

(Ex-Officio)

MANSFIELD MERRIMAN *(Term Expiring in 1919)*
A. A. STEVENSON *(Term Expiring in 1920)*
W. H. BIXBY *(Term Expiring in 1921)*

FINANCE COMMITTEE

GUILLIAEM AERTSEN *(Chairman)*
GEORGE K. BURGESS
C. D. YOUNG

Assistant Secretary

C. L. WARWICK

Office: University of Pennsylvania, Philadelphia, Pa.

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